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Campuses, Cities and Innovation

39 international cases accommodating tech-based research

Flavia Curvelo Magdaniel
Alexandra den Heijer
Monique Arkesteijn
Hans de Jonge

Campuses, Cities and Innovation

39 international cases
accommodating tech-based research

by

TU Delft

Campus Research Team

May 2017

Note for the reader:
This book is also available as a full colour paperback.
See www.managingtheuniversitycampus.nl for more information

Colophon

This book "Campuses, Cities and Innovation" comprises a reprinted chapter and components from Flavia Curvelo Magdaniel's doctoral thesis entitled 'Technology campuses and Cities: A study on the relation between innovation and the built environment at the urban level'. This PhD thesis was defended and published in 2016 at Delft University of Technology (TU Delft). The content corresponds to a study of 39 technology campuses, which was conducted in 2013 and was edited by members of TU Delft's Campus Research Team, between February and April 2017.

Author:

dr. ir. Flavia T. J. Curvelo Magdaniel, post-doctoral researcher 'The European Campus' project, specialisation: campus development and innovation districts

Editorial team:

dr. ir. Alexandra C. den Heijer, leading researcher "Campus Research Team", associate professor Real Estate Management, specialisation: (managing) university campuses

ir. Monique H. Arkesteijn MBA, project manager, assistant professor and head of section Real Estate Management, specialisation: design and decision support

prof. ir. Hans de Jonge, emeritus professor Real Estate Management, founder "Campus Research Team", former department chair

All members of the Campus Research Team are affiliated to the academic department of Management in the Built Environment (MBE) of TU Delft's Faculty of Architecture and the Built Environment. Contact address: f.t.j.curvelomagdaniel@tudelft.nl. More background information about this book and related research can be found at www.managingtheuniversitycampus.nl

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Preface

The locations of technology campuses determine where innovation takes place. In a knowledge-based economy the future of cities increasingly depends on the presence of universities, their industry partners, talent and (start-up) businesses. The relationship between (technology) campuses and cities was a central theme in Flavia Curvelo Magdaniel's doctoral research, which was defended and published in September 2016. During her PhD study she collected data of thirty-nine technology campuses, which we – as her promotor and copromotor – considered worth a spin-off publication.

This publication "Campuses, cities and innovation" contains descriptions of 39 international cases that accommodate tech-based research activities. These case descriptions (in part B) are introduced with background information about concepts and methods (in part A) and reflected upon in conclusions and recommendations (in part C).

Based on our experience - after more than twenty years of campus research at TU Delft – we identified a demand for case-study references to support decision making at both universities and municipalities. TU Delft's campus research team aims at generating management information on all campus levels: from the changing academic workplace and new concepts for university buildings to the sustainable campus and the knowledge city. This book is part of a book series that combines insights from theory with references from practice, to contribute to smarter campus management.

With a large amount of facts, figures and maps this book "Campuses, cities and innovation" is relevant for board members and (campus) management staff at universities as well as policy makers at municipalities and regional authorities. Additionally, decision makers of industry partners, (start-up) businesses and (other) members of the campus community could be interested in comparing their campuses with world-wide examples.

"Innovation is what happens when preparation meets opportunity" was one of the propositions that Flavia Curvelo Magdaniel defended in September 2016. With this book we wanted to take the opportunity to support the preparation process and hope to stimulate innovation.

prof. ir. Hans de Jonge
dr. ir. Alexandra den Heijer
on behalf of TU Delft's Campus Research Team

Delft, May 2017

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Management summary

Introduction (Chapter 1)

This book describes the development of thirty-nine technology campuses intended to stimulate innovation. 'Technology campuses' entail a variety of built environments that have been developed to accommodate technology-based research activities. Science parks, campuses of universities of technology and R&D parks – facilitating research and development – are the most common examples of them. Universities, firms and governments are spending resources in developing these large and costly built environments to support their goals based on spatial models that have a common characteristic: they enable the concentration of people, organisations, and their activities. This approach is being criticised because the actual returns of these investments on innovation are difficult to demonstrate. Nonetheless, developing campuses to stimulate innovation has become a commonly accepted practice among the three organisational spheres of the Triple Helix in some cities and regions of industrialised countries.

Developing information about technology campuses is important for both researchers in the built environment and campus decision makers interested on stimulating innovation. This importance is related to the growing complexity of accommodating research activities due to key aspects characterising the knowledge-based economy. Among others, there is a growing range of technology based activities, research universities are regarded as economic engines, there are more companies investing in R&D, and people are changing their mobility patterns due to globalisation. In this dynamic context, the built environment is gaining importance because it is not only a shelter facilitating research activities but it can be a symbol attracting and representing organisations and research communities. The variety of built environments that technology campuses entail has been studied predominantly in the fields of planning, urban and regional studies, businesses, science and technology but much less from the built environment perspective. Despite its relevance, our existing knowledge of technology campuses is limited. In order to fill the existing knowledge gap in research, this study explores both, the demand for- and supply of technology campuses as built environments with 39 examples in the empirical word.

Generally, this knowledge will help defining technology campuses as physical environments, creating a knowledge basis for further research investigating these areas in the real estate management and urban development fields. This study addresses as main question: **What are the distinct characteristics of technology campuses from the built environment perspective?**

Concepts: knowledge, innovation and the built environment (Chapter 2)

This study establishes scientific links between different fields addressing the contemporary relevance of technology campuses for innovation. On the urban side, the concept of knowledge-based development (KBD) connects socio-economic and spatial aspects of innovation. Cities and regions are considered the geographic units supporting the production of knowledge and where the interaction of relevant stakeholders enabling this process takes place. The built environment is an essential part of the entire KBD system because it shapes the city and accommodates the production of knowledge. In turn, major shifts in economic structures and ICT developments related to KBD have had specific impacts on the built environment and its management at different scale levels. At building level, the changing ways of doing research call for different approaches in the provision of workplaces in both, academic and industrial environments. At area level, there is a demand for concentrating research activities in close proximity to specific organisations and places. Last, the involvement of various stakeholders with their different interests on innovation at urban and regional level poses interesting and challenging questions about the governance of these areas.

On the real estate side, this study provides a way of understanding technology campuses as strategic and operational assets for organisations. Technology campuses are described in these terms and in relation to concepts from design and planning theories on the one hand and innovation topics in urban economy on the other hand. This multidisciplinary view of technology campuses is used to outline its relevance in the contemporary context and to develop a conceptual framework to describe them.

Methods (Chapter 3)

This book describes technology campuses by using a qualitative survey of 39 international cases. This method allowed exploring, describing and comparing the variety of technology campuses. Since campus development is the subject under examination, this qualitative survey used documentation analysis rather than questionnaires for data collection (accessed in 2013). In order to have an integral description of technology campuses as built environments, this study uses an approach from CREM/PREM theories, by which campuses are seen as real estate objects from four different perspectives: strategic, financial, functional, and physical. Similarly, the city is seen as the strategic, economic, functional, and physical context of campuses. Based on existing campus management theories, this study collects four types of datasets: strategic, financial, functional, and physical.

Emergence and development of technology campuses (Chapter 4)

Technology campuses located across 16 industrialised countries in North America, Europe, and Asia-Pacific emerged and developed over the 20th century. Indeed, the empirical information collected from the survey ratifies that the development of technology campuses as a built environment phenomena is linked to three periods of technological development in industrialised countries: (1) the post-war period or atomic age, (2) the space age and ICT industrial revolution and (3) the digital and information age.

The number of technology campuses has increased over the years. During the post-war period or atomic age (9% of the sample), a pattern is observed between the development of technology campuses and the attention placed to advancing technologies after the WWII in the U.S.A., Russia and Europe. During the space age and ICT industrial revolution (41% of the sample), the emergence of the first technology campuses in Asia is linked to the entrance of Japan and South Korea in the computers and electronics market, and the support of national governments encouraging industrial development in these countries. Similarly, more developments emerged in Europe as part of wide-national strategies to encourage sciences and technology. During the Digital and Information age (40% of the sample), the latter pattern of development increased both in Europe and Asia with the increasing attention of tech-based research in the knowledge economy. This intensification of campus developments is specially perceived in Europe.

Overall, understanding the emergence and development of technology campuses helped revising the definition of technology campuses. The following definition of technology campuses as seen in this study connects different fields such as architecture, urban design, real estate management, planning, economic geography and business:

'Technology campuses are built environments facilitating the concentration of organisations in designated areas. They have been planned and/or evolved to accommodate tech-based research activities leading to the advancement of technologies, which are believed to be a result from the expected interaction among the organisations performing such activities'.

Patterns in the demand for Technology campuses (Chapter 5)

Technology campuses have been developed by three main types of organisations: universities; companies and governments. These types are recognised as the spheres of the so-called Triple Helix concept: university-industry-government. Within these three spheres three main stakeholders' roles have been identified, whose (inter) actions have made campuses possible: founders, managers and promoters. Thus, a large number of stakeholders and roles are identified. Some entities play more than one or two roles in the development of technology campuses over time and they are therefore identified as key stakeholders. Positioning the different bodies that were involved in the development of technology campuses in relation to the spheres of the Triple Helix shows how each of them are relatively independent and have distinct status. Conversely, positioning these roles in the triple helix spheres may help to identify potential areas of cooperation to develop the technology campuses suggesting a degree of alignment in goals between these spheres.

Largely, the goals driving campus developments are diverse and multiple within one case (12 main different goals). For instance, while differentiation is outlined in some founding visions of technology campuses and their hosting cities, similar goals and concepts are identified in several of them with a clear tendency at encouraging social and economic development. 'Encouraging innovation for economic growth and development' is the most popular goal among technology campuses (64% of the sample address this goal). 'Encouraging academia, science and R&D for economic growth' is the most popular goals addressed both in campuses and the cities (87% of the sample). The goals of technology campuses essentially reflect the actions or initiatives carried out by cities or regions to succeed as knowledge-based cities/regions identified in literature and policy documents. The tendency of universities and companies having similar goals addresses the possible influence of the economic relevance of the Triple Helix relationships on the overlapping roles of its constitutive organisations and so, the direction of their goals, including their real estate goals.

Patterns in the supply of technology campuses (Chapter 6)

Four common patterns in the supply of technology campuses are empirically described in this study: location, layout structure, size and density and block pattern. These characteristics emphasise the forms and functions of campuses and the concentration of research activities.: The four characteristics emerging from the empirical data are interrelated and altogether can be used to describe the supply of technology campuses as follows:

- **The location** shows most technology campuses (1) are found in industrialised regions: 54% in Europe and 10% in North America; (2) they have a border condition regardless its relation with the hosting city (87% of the sample); and (3) they are near to (or in) universities' locations: 56% of the sample is within 15 minutes by foot and 71% of the sample is within 30 minutes by public transport. Similarly, the analysis of this characteristic shows 5 different relationships between campuses and their hosting cities/regions (Equals 8%, Contains 28%, Overlaps 13%, Touches 36% and Disjoints 15%). These relationships are associated with specific spatial dynamics in their contexts showing most campuses are in transition due to urbanisations processes (77% of the sample in the categories Contains, Overlaps and Touches).
- **The layout** emphasises the clustered character of technology campuses as built environments, which is dominated by compact and practical arrangements in their designs (46% of the sample). Nevertheless, the study of this characteristic also shows that although practical arrangement is very common in the design of campuses (71% of the sample)many campuses are also dispersed due to their large size (38% of the sample).
- **The size and the density** show technology campuses occupy large pieces of land intended to accommodate large populations in cities/regions. Together, technology campuses occupy 69.600 hectares (1.800 hectares on average). However, there are marked differences in their physical size (the surface of technology campuses ranges from 28 up to 23.800 hectares. The latter is Kansai Science City, an unincorporated city between three prefectures in Japan). In terms of users, the size of technology campuses is equally diverse. Together, they have 1,3 million users (3.700 users on average). However, the users' range is wide (between 210 and 238.000 users). Not surprisingly, the largest campuses in size and users are those considered as Equals (i.e. the campus is the same as the city). When looking at the density, one can say technology campuses have a relatively low density (99,5 users per hectare on average). The densest campus has 438 users per hectare while the least dense campus has one user per hectare.
- **The block pattern** shows that all technology campuses are designed and built with the idea of self-standing buildings on the ground as predominant building unit. The analysis shows an association between these patterns influencing planning principles of modern architecture during the 20th century. Examples of these principles are deliberated the use of orthogonal configurations (21 cases), grid-shaped blocks (14 cases), closed road networks (19 cases) and invisible superblocks (8 cases).

Overall, these characteristics are relevant campus planning and design aspects to focus the attention, considering their persistent association with theoretical concepts explaining innovation (e.g. proximity, accessibility, interaction, and diversity). Certainly, the descriptive nature of this research cannot tell whether these concepts have influenced the planning and design practices in technology campuses. However, the interrelationships between these concepts and the physical characteristics of technology campuses can be further investigated.

A compendium of Technology campuses (Chapter 7)

This book summarises the descriptive data collected per each technology campus in a compendium. In general, this compendium organises the information in a way that is suitable to compare the similarities and differences between the many built environments that technology campuses entails. Thus, Chapter 7 contains the descriptive data for each of the thirty-nine campuses studied, as well as the contexts in which they have emerged and evolved. The data of this compendium is presented in single 'profile pages' for each of the campuses and their hosting cities. The data is organised into general, strategic, functional, and physical data according to the data collection procedures (See Figure i).

Technology campuses as built environments (Chapter 8)

Until now, technology campuses have remained roughly unexplored from its physical dimension. This study provides a comprehensive overview of technology campuses, showing that built environments with particular characteristics (in terms of demand and supply) have shaped the concentration of research activities in different locations around the world (See Figure ii). On the one hand, the demand for technology campuses is characterised by the explicit intention to concentrate research activities in a single location in a deliberate manner. Universities,

Strategic data

Location pattern

Financial data

Stanford Research Park

Palo Alto, California, USA

Touches
Overlaps

Ext. promoters: Prom2: City of Palo Alto play a role as promoter in branding and marketing for business location.

Funding campus: **Private**: Stanford University

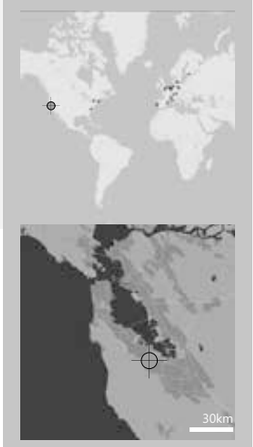
Controllers campus: **Defined**: Stanford Real Estate

Vision city: V2-Goals: Encourage innovation and technology; Make the inner city attractive and vibrant; Encourage diversification of the economic base./ V4-Motto: 'Birthplace of the Silicon Valley'

Vision campus: V4-Motto: Great ideas growth here.

Code: **1-SRP**

Year: **1951**



By Jrissman (Own work) (CC-BY-3.0) via Wikimedia Commons

Official denomination:
Changed: from Industrial Park (origins) to Research Park (2013)

Generic data

financial | strategic

physical | functional

Scale campus: **M** (Area in a District)

Land use area: **283 ha**

Density city: **1.041** inh./sq km (*USCB, 2010) *converted

Transportation City: Bus, Caltrain and Bike

Distance campus to:

Airport	City centre	University
32 km	4,9 km	4,1 km
90'	30'	10'
San Jose Airport	Palo Alto Caltrain Station	Stanford University

Population campus: **23.000**
(P1-Employees: 23.000) *1990s

Orgs. in campus: **151**
O1:150 companies
O2: 2 offices, 1 School; 1 Library; a Medical Centre and Hospital of Stanford University.

Facilities in campus: F1: Restaurants, Cafes
F2: University Club; Sport facilities
F3: Hospital, Medical Centre

F1
F2
F3

Population city: **66.363** (USCB, 2012, est.)

Employment city: **98.000**
Main employers-staff: Stanford University

Tertiary education city: **1** university (Stanford University, R-2)

Amenities city: A1: 5 branch libraries, 4 museums
A2: 3 shopping centers; downtown shopping district; >100 restaurants in downtown; 1 amusement park
A3: Several parks; 3 Golf Courses;

A1
A2
A3

Named initially Stanford Industrial Park, was the first of its kind and became the cornerstone of what would eventually be known as Silicon Valley. Nowadays, called Stanford Research Park, is still home to the main headquarters of Hewlett-Packard and recently Facebook's headquarters. Since the early 1990s, many large American law firms have established Silicon Valley branch offices in or near the park.

Cluster base campus:
R&D: Mostly scientific, technical and research oriented in the fields of electronics, space, biotechnology, computer hardware and software.

Economic base city:
Consolidated: High tech businesses.

Physical data

Functional data

Fig.i Example of profile pages per each technology campus featuring the type of data described.

R&D firms, research institutes and governments are the main stakeholders involved in the development of technology campuses as founders, managers and promoters of these built environments. This demand emerged and developed during critical periods of technological advancements during the 20th century. Nowadays, most of these built environments accommodate multiple organisations that perform research activities in a broad range of technology fields to support different core businesses. The most common fields are biotechnology, information sciences, energy, materials and engineering.

On the other hand, the supply of technology campuses is more heterogeneous, because it is described through various characteristics. Empirical evidence supported the existence of differences but also marked similarities describing the supply of technology campuses regarding location, layout, size, density, and block pattern. This research indicates that some of these characteristics are the result of explicit intentions of planners and designers. These findings emphasise the character of these built environments as preconceived or ideal models envisioned as part of comprehensive plans influenced by multiple stakeholders. Their intentions to concentrate research activities in one place are translated into design and planning principles that gave shape to an archetype that has been replicated -with slight variations- in many places up today.

The description of technology campuses as built environments provides an empirical ground to develop further research and examine its subject of study from a development perspective. To begin with, the research presented in this book has served as the empirical ground of a doctoral thesis entitled 'Technology campuses and Cities: A study on the relation between innovation and the built environment at the urban level' (Curvelo Magdaniel, 2016). Similarly, these findings can be useful to other researchers in the fields of real estate management, urban development management, architecture and urbanism investigating these and similar areas in the context of the knowledge economy. 'Innovation, cities and campus governance' as well as 'Campus locations and the urban transformation' are addressed as relevant avenues for further research.

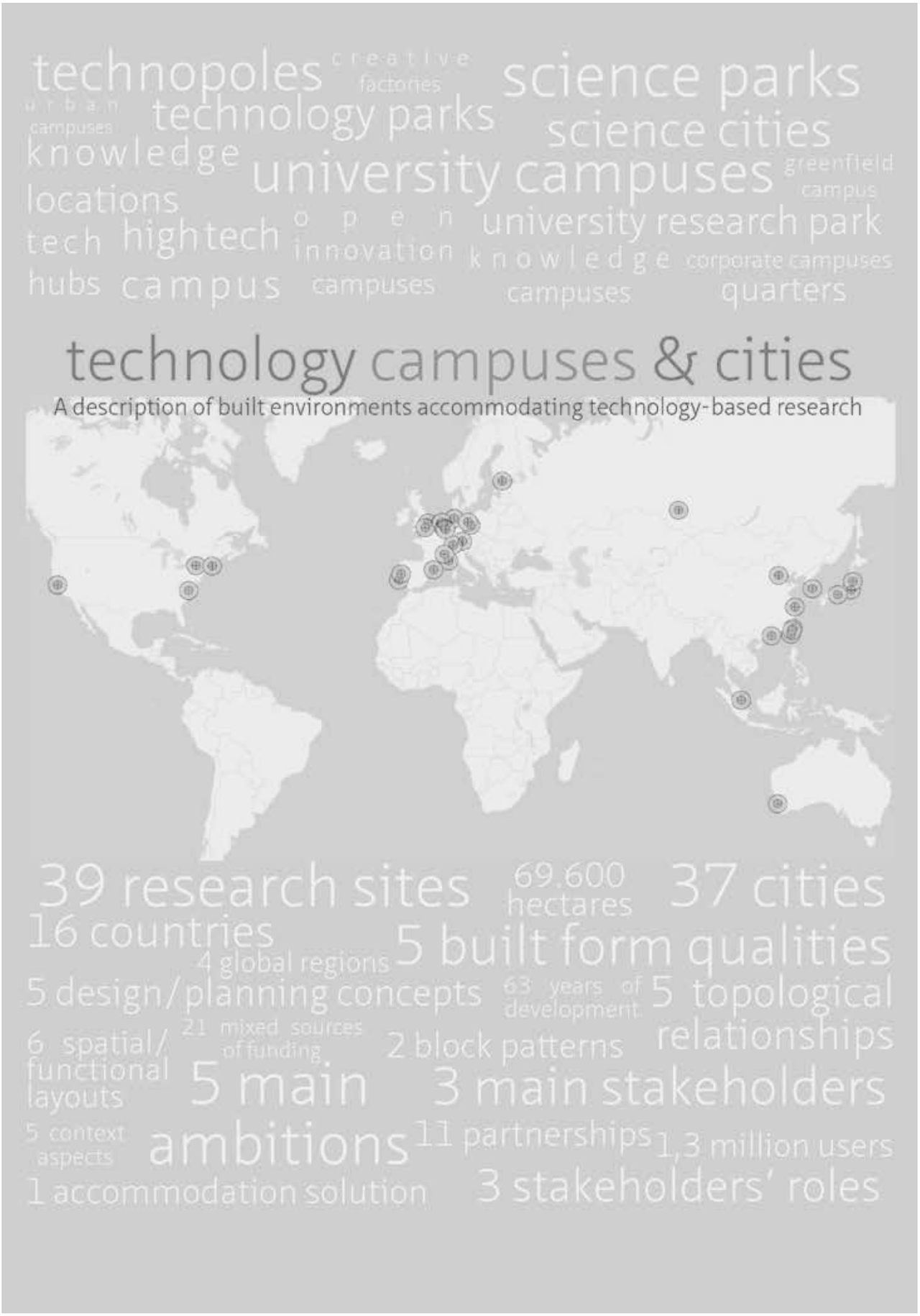


Fig.ii Comprehensive overview of technology campuses described in this book

ilicon Britain: Inside the country's tech usters

hris Vallance
orrer, BBC Radio 4

March 2012 | Technology

The University: A Web of Arteries
Feeding a City with Ideas

14 SEP 2012 / ALASTAIR BLYTH

In depth: What is the point of Tech City?

SILICON EUROPE / 16 MARCH 12 / by OLIVIA SOLON

FORTUNE

Where the American Startup Dream is Moving: Downtow

by Bruce Katz, Julie Wagner @bruce_katz JUNE 13, 2014, 10:22 AM EST

February 26, 2012 6:58 pm

High-tech: Science park seeks a fresh vision

By Pierre Tran

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Friday, Mar 28, 2014

Welcome to the Googleplex: Internet gia to build $120m futuristic HQ with a garde on the roof (and no employee will be mo than 2.5 minutes walk from a co-worker)

By DAILY MAIL REPORTER

PUBLISHED: 10:44 GMT, 24 February 2013 | UPDATED: 08:54 GMT, 25 February 2013

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CIC Boston's latest move points to where things are heading

Nobody Calls It the 'Innovation District' Anymore — Even the Mayor

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-delivery firm and crowdfunding site among 13 companies inducted into ernment-backed Future Fifty scheme for fast-growing start-ups

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Tibco sells Stanford Research Park campus for $330 mill

Mar 11, 2015, 3:56pm PDT Updated Mar 11, 2015, 3:20pm PDT

The Boston Globe
REAL ESTATE

Feb 18, 2016, 7:17am EST

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July 6, 2012 by Eleonore Dailly

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December 19, 2013

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By Sean Coughlan
BBC News education correspondent

27 June 2012 | Business

New York's Roosevelt Island to get technology campus

26 June 2012 Last updated at 18:34 BST

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VOL. CXXIII—NO. 74 FRIDAY, SEPTEMBER 11, 2009 WWW.COLUMBIASPECTATOR.COM

February 11, 2016 Updated 02/15/2016

City to invest $7.2 million in new hubs to bolster tech

The hubs, one at the Brooklyn Navy Yard and the other near Grand Central Terminal, will debut this s

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March 2012

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WASHINGTON
Spectator Senior Staff Writer

will be suspended, a portion of 125th Street closed, and left turns from 125th Street onto

INDEPENDENT

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The Washington Post

Education

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Posted Jun 7, 2011 by Alexis Tsotsis (@alexis)

Next Silicon Valleys: Why Cambridge is a start-up city

By Katie Hope
Business reporter, BBC News

24 March 2014 | Technology

Een campus heeft meer nodig dan een 'mooi weiland' om te bloeien

maandag 3 december 2012, 0:00
Update: woensdag 20 augustus 2014, 1:00

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In 2009, Moscow unveiled an ambitious plan to build a world-class technology incubator. Then corruption, brain drain, and Putin killed it.

Forbes / Pharma & Healthcare FEB 4, 2014 @ 09:00 AM 80,339 VIEWS

7 Reasons It's Finally Time To Live In Research Triangle Park

A. Background

1. Introduction

1.1. Research field

This book describes the development of thirty-nine technology campuses intended to stimulate innovation. 'Technology campuses' entail a variety of built environments that have been developed to accommodate technology-based research activities (e.g. science parks, campuses of universities of technology, R&D parks, among others). In this book, the built environment is seen as a resource managed to attain organisational performance, while stimulating innovation is seen as a particular organisational goal. This goal has become increasingly important for different types of organisations in the knowledge-based economy (e.g. universities, firms, and municipalities). In this view, technology campuses are studied as resources supporting the goal of stimulating innovation in multiple organisations.

Developing knowledge about technology campuses as built environments is an essential part of this book. An exploratory research that uncovers and positions technology campuses in a broad theoretical and empirical context is used to develop such knowledge. This introduction chapter describes the rationale of this book and the ways in which the research has been conducted. First, it describes the societal and scientific relevance of the research topic as a background that justify this study. Then, it states the knowledge gaps that led to the formulation of the main research questions and goals. Last, this chapter concludes by describing the outline of this book and providing relevant definitions for its readers.

Technology campuses, innovation, and cities in the knowledge economy

In the current economies of many industrialised countries, creating and applying knowledge is the basis of competition. As Porter asserts in his influential work 'a nation's competitiveness depends on the capacity of its industry to innovate' (1990, p. 73). Today, this capacity seems to depend on the collective effort of three organisational spheres - universities, industry, and governments- also known as the Triple Helix (Etzkowitz, 2008). In order to remain competitive, these organisational spheres pull together several resources to stimulate innovation as a strategic goal (e.g. people, capital, technology, knowledge, infrastructure, etc.). In this context, the built environment is an important resource supporting the fulfilment of this organisational goal.

There is a diversity of built environments accommodating a range of technology-based research activities, which are essential in creating and applying knowledge as basis for competition. These built environments were mostly developed over the 20th century (particularly after the WWII) with the deliberate objective to support technology-based development in industrialised countries across North America, Europe and Asia.

Since the late 1980s, the development of technology campuses to stimulate innovation has gained importance both, in practice and in theory (Carvalho, 2013; Castells, 1985; Castells & Hall, 1994; Huang, 2013; Link & Scott, 2006; Van Winden, 2011) with the so-called knowledge-based economy[1]. In this economy, developing technology campuses has become a milestone resource to stimulate innovation for economic development

'Technology campuses' entail a variety of built environments that have been developed to accommodate technology-based research activities (e.g. science parks, campuses of universities of technology, R&D parks, among others).

not only in highly- and new industrialised countries, but also in emerging and developing economies. Universities, firms and governments are spending resources in developing large and costly built environments to support their goals based on spatial models that have a common characteristic: they enable the concentration of people, organisations, and their activities. This approach is being criticised because the actual returns of these investments on innovation are difficult to demonstrate.

Nonetheless, developing campuses to stimulating innovation has become a commonly accepted practice among the three organisational spheres of the Triple Helix in some cities and regions of industrialised countries (See example in Fig.1.1). Nowadays, there are many types of technology campuses that has been defined, labelled, and studied in different ways – i.e. Technopoles (Castells & Hall, 1994), Science parks (Link & Scott, 2003, 2006), University campuses (Den Heijer, 2011), Knowledge hot-spots (Van Winden, 2011), Hi-tech parks (Huang, 2013), Knowledge locations (Carvalho, 2013) among others. Roughly, there is at least one example of this practice in almost every city of an industrialised country.

Most of these built environments have been developed in peripheral –and sometimes isolated- locations lacking the liveability of inner-city centres, which is debated in economic geography as the true geography of innovation (Beaudry & Schiffauerova, 2009). Recently, a new urban agenda regarded as 'Innovation districts' (Katz & Wagner, 2014) has emerged criticising the science park model, and calling for new urban development schemes embracing the city as the place for innovation. This metropolitan policy report highlights innovation districts as a means for urban competitiveness and prosperity. As a result, several American cities have launched their 'innovation district strategy' to spur economic growth[2]. In Europe, cities have begun labelling urban developments as 'innovation districts' in an explicit way[3]. Similarly, these types of developments has called the attention of urban scholars who currently debate how to quantify innovation, entrepreneurship, and vitality in cities (MIT, 2016) and try to understand how they differ per regions and stakeholders involved (TU Delft, 2017).

Certainly, accommodating research as an innovative activity is growing complex with key aspects characterising the knowledge-based economy. For instance, the range of technology-based research activities has increased, both in numbers and related processes with the advancements of technologies during the ICT industrial revolution, and the digital and information revolution (Headrick, 2009). Universities are increasingly addressed as the engines of the knowledge-based economy because their primary process lies in research next to educating future researchers (Vorley & Nelles, 2008). Many companies –especially in developed economies- invest on R&D and are increasingly engaged in these activities with universities (World Economic Forum, 2011). Correspondingly, the number of people employed in research is growing steady in many countries (OECD, 2013). With

[1] The knowledge-based economy is a concept discussed in political and economic giving economic significance to knowledge, which meaning is closely associated with science, technology, and innovation. A definition used in this research is given at the end of this chapter.
[2] Examples of these are Detroit, Miami, Chicago, Fremont, Minneapolis, Boston, among other cities.
[3] Examples of these are Rotterdam, The Hague, Barcelona, and Manchester.

Fig.1.1 An example of a technology campus developed to stimulate innovation, which construction started in 2014.

Universities, firms and governments are spending resources in developing large and costly built environments to support their goals based on spatial models that have a common characteristic: they enable the concentration of people, organisations, and their activities. This approach is being criticised because the actual returns of these investments on innovation are difficult to demonstrate.

globalization and the changing dynamics of mobility patterns, most of the competitive advantage of countries and organisations relies on their ability of attracting and retaining talented people. As a result, places (regions, cities and areas) have become more important than ever because the new location factors depend on the quality of the knowledge institutions (Faggian & McCann, 2009; Van Den Berg et al., 2005); and the living and working conditions preferred by the highly educated worker (Florida, 2008). In this dynamic context, the built environment is gaining importance because it is not only a shelter facilitating research activities but it can be a symbol that attract and represent a research community.

The relationship between technology campuses, innovation and cities in the knowledge economy provides a multidisciplinary research field for this study. On the one hand, this research approach to study technology campuses as built environments is based on theoretical assumptions from Corporate Real Estate Management (CREM)[4]. On the other hand, to understand the relevance of these built environments for innovation, this research explores theoretical notions from regional studies, urban planning and urban design.

1.2. Knowledge basis: gaps and opportunities

'Technology campuses' is a relatively unfamiliar topic in the literature. The variety of built environments that technology campuses entail has been studied predominantly in the fields of planning, urban and regional studies, businesses, science and technology but much less from the built environment perspective (See Figure 1.2). Only few technology campuses have been studied from a built environment perspective (Den Heijer, 2011; Hoeger & Christiaanse, 2007). Den Heijer's approach on university campuses as real estate objects provides a knowledge basis to describe them as built environments from four different perspectives (i.e. strategic, financial, functional and physical). Accordingly, there is a particular demand for developing these areas, which has been more or less explicitly addressed in existing studies in regional studies and the like. However, the demand is just one side of this reality. Generally, technology

[4] Corporate real estate management (CREM) is defined as 'the management of a corporation's real estate portfolio by aligning the portfolio and services to the needs of the core business (processes), in order to obtain maximum added value for the business and to contribute optimally to the overall performance of the corporation' (Dewulf et al., 2000). Studies in this field focus on the practice of real estate management (REM) from the end-user's view, which deals with activities that vary from developing real estate strategies and building projects, up to maintaining and managing the built space in the portfolio of a private or public organisation.

campuses not only require a good vision a substantial capital investments but also large pieces of (sub)urban land and other infrastructure resources, which can take years of development.

Despite its relevance, our existing knowledge on the supply of technology campuses is limited. In order to fill the existing knowledge gap in research, this study explores both, the demand for- and supply of technology campuses as built environments with examples in the empirical word. This information is particularly important for researchers investigating these areas from corporate real estate, urban development and urban planning perspectives but also for campus decision makers interested on stimulating innovation (e.g. campus policy makers, planners, designers, controllers and users).

Overall, describing technology campuses deserves attention for two reasons. In academy, it will provide new knowledge on the campus development practices in terms of demand and supply (e.g. stakeholders involved and their ambitions and the campus physical and functional structures in relation to their hosting cities/regions). From this knowledge not only observations but also trends can be identified. In practice, this knowledge can be transformed into information campus decision-makers can use to position and compare their practices in an international context. Finally, this can stimulate new ways of thinking among stakeholders involved in the development of existing and new areas when dealing with the current challenges of accommodating tech-based research activities.

Despite its relevance, our existing knowledge on the supply of technology campuses is limited. In order to fill the existing knowledge gap in research, this study explores both, the demand for- and supply of technology campuses as built environments with examples in the empirical word.

1.3. Research aim and questions

This study aims to uncover and describe the general patterns in the demand for- and the supply of technology campuses in an international context. This knowledge will help defining technology campuses as built environments, creating a knowledge basis for further research investigating these areas in the real estate management and urban development fields.

This study addresses as main question: What are the distinct characteristics of technology campuses from the built environment perspective? Next to it, the following set of sub-questions will guide this empirical exploration, which are related to this book outline:

- Why are technology campuses important? (Chapter 2)
- How to describe technology campuses? (Chapter 3)
- When and where did technology campuses emerge and develop? Are there evident patterns in their emergence and development? (Chapter 4)

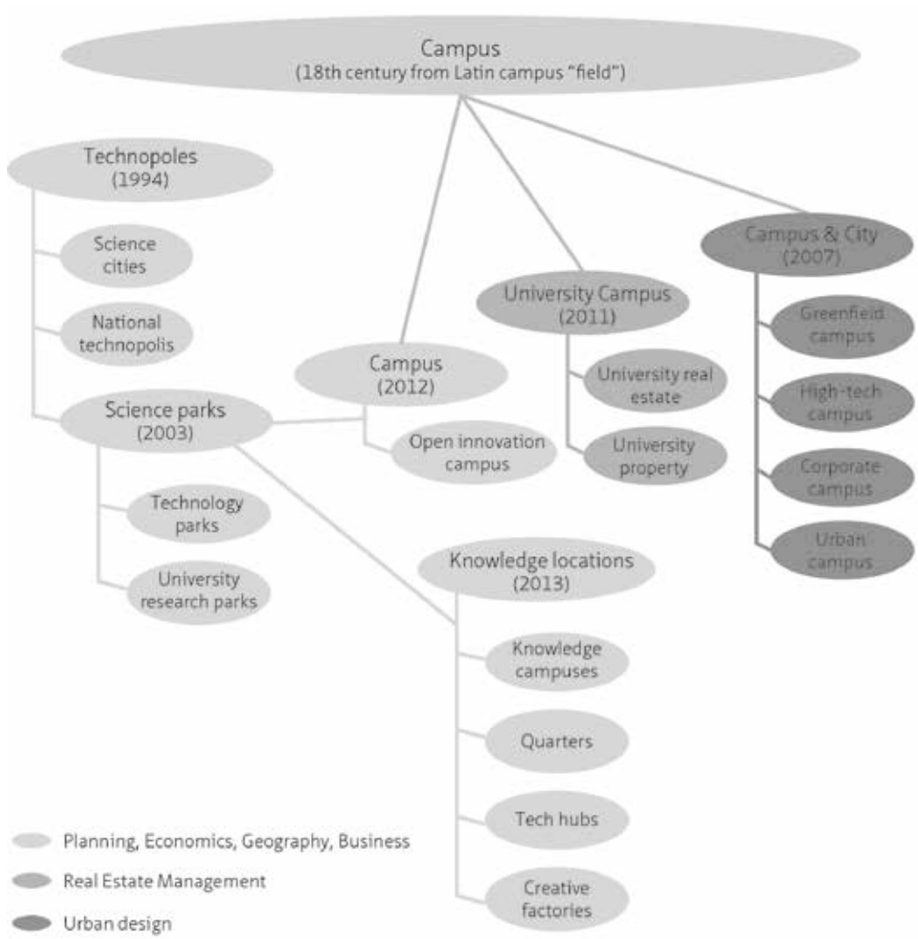


Fig.1.2 Diversity of built environments covered by the definition of technology campuses given in this research. They are distinguished per field of study documenting the concentration of research activities in society.

- Who are the stakeholders involved in the development of technology campuses? What are their goals? (Chapter 5)
- Are there common patterns in the supply of technology campuses? What characteristics define the supply of technology campuses? (Chapter 6)
- How do campuses compare to each other? (Chapter 7)

1.4. Book structure and outline

This book is structured in three parts containing chapters answering each of the previous questions. Part A (Background) consists of three chapters. Chapter 1 has already introduced the study by providing background information that describes the relevance, purpose and guidelines of this research. Chapter 2 explore the contemporary literature positioning technology campuses as relevant subjects of study. This part concludes with Chapter 3 explaining how this study goal is going to be achieved by describing the methods used for data collection and analysis in the search for patterns in the demand for- and the supply of technology campuses.

Part B (Description) consists of four chapters containing descriptive information from the empirical study of technology campuses. Chapter 4 describes three periods of technological developments in which technology campuses have emerged and developed in an international context. Chapter 5 describes the general patterns in the demand for developing technology campuses by outlining the stakeholders and the goals involved in their strategic and financial structures. Chapter 6 describes the general patterns in the supply of technology campuses by describing their functional and physical characteristics. This part concludes with Chapter 7 that provides a comparative overview of the descriptive information per each of the thirty-nine campuses studied.

Finally, Part C (Synthesis) consists of Chapter 8. This chapter draws the conclusions of this study and how its findings can be used further in research and practice. At the end of the book, some practical information is added in the appendices. The relationship between the book parts, chapters and questions is also summarised in Table 1.1 that can be used as reference.

1.5. Definitions

This book uses key terms that need explanations for its readers because they entail particular meanings. The following definitions deserve special attention in this study. Other definitions are addressed in particular chapters when required.

Built environment
As described in architecture theories, built environments consist of built forms created by humans, to shelter, define and protect activity. In this research, the term built environment is used as a synonym of 'real estate', which according to theories in the management of the built environment is seen as an enabler of the activities performed by individuals, organisations and the society. This research distinguishes three scales of the built environment: building, portfolio and urban areas. This research recognises Technology campuses as built environments at the scale of the urban area.

Knowledge-based economy
Although there are many definitions addressing this term, this research adopts an existing view on this term from regional development studies, which distinguishes that this economy had emerged in the 1950s focusing on the composition of the labour force and has developed by adding structural aspects such as technological trajectories and institutional frameworks (Cooke & Leydesdorff, 2006). Accordingly, the knowledge economy is seen as a system perspective used by governments to frame their perspectives for developing science, technology and innovation policies.

Innovation
Innovation has multiple views. In this research, innovation is regarded as the processes of knowledge creation, diffusion and its further application in the development of new and improved technologies. These processes are seen as essential for the competitive advantage of multiple organisations in industrialised economies. Stimulating innovation is, therefore, a common goal of many organisations.

	RESEARCH QUESTIONS IN RELATION TO CHAPTERS AND RESEARCH APPROACH	
	Research questions	**Chapters**
I. Background	What is the main purpose of this study and	Chapter 1. Introduction
	Why are technology campuses important?	Chapter 2. Concepts
	Which approaches and methods suit best achieving this study purpose?	Chapter 3. Methods
II. Description	When and where did technology campuses emerge and developed? Are there evident patterns in their emergence and development?	Chapter 4. Emergence and development of technology campuses
	Who are the stakeholders involved in the development of technology campuses? What are their goals?	Chapter 5. Patterns in the demand for technology campuses
	Are there common patterns in the supply of technology campuses? What characteristics define the supply of technology campuses?	Chapter 6. Patterns in the supply of technology campuses
	How do technology campuses compare to each other?	Chapter 7. A compendium of technology campuses
III. Conclusions	What are the distinct characteristics of technology campuses from the built environment perspective?	Chapter 8. Conclusions and recommendations

Table 1.1. Relationship between research questions and chapters through the book structure

Technology–based research is, therefore, an essential activity addressed in this study because integrates all the three processes linked to innovation: knowledge creation, diffusion and its application. The human dimension is inherent to these processes because they involved tacit knowledge (i.e. knowledge embedded in people). The process of knowledge diffusion is key in this context because it enriches knowledge creation and its application (e.g. knowing what other researchers do and connecting this knowledge to their own work might drive knowledge further and also enhance possibilities for collaboration to create more knowledge or to apply this knowledge). In this view, this research refers to innovation also as a learning process addressing the human dimension interrelating these processes.

Technology-based research

This term refers in this research to both, (1) fundamental or basic research and (2) research and development activities, which have a focus on the advancement of technologies in various fields. Essentially, technology-based research entails the processes linked to innovation as seen in this research.

Organisations

Organisations are systematically arranged frameworks relating resources (e.g. people, knowledge, capital, technologies, etc.) in a design intended to achieve specific goals. This definition is adapted from management theories (Clegg et al., 2008). This research has chosen to use the term technology-based research organisations to refer to a specific type of knowledge-intensive organisations such as: research universities or institutes in technology fields and R&D companies in high technologies.

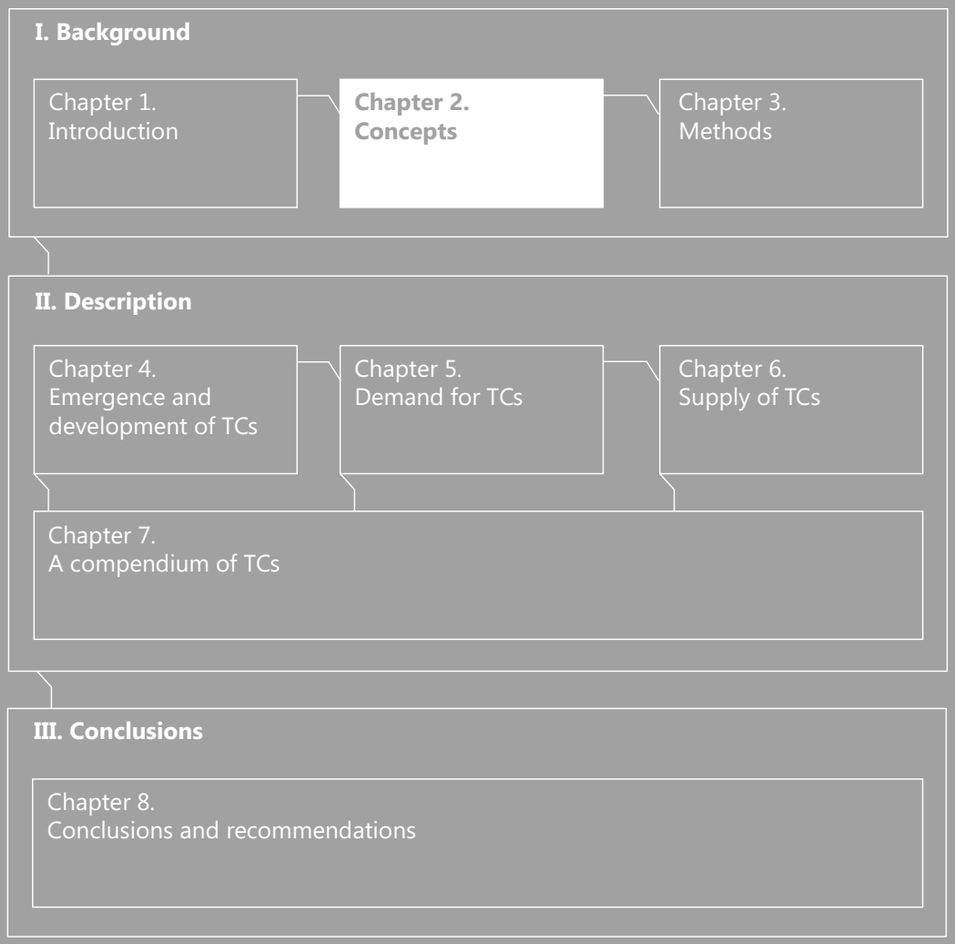
Stakeholders

Stakeholders are individuals, organisations, or institutions, whose interests are involved or affected by a course of action. For instance, any decision on the built environment counts as a course of action. Thus, there are several stakeholders involved in the development of technology campuses whose interests can affect and be affected by such developments.

focal /ˈfəʊkl; AmE ˈfoʊ-/ ... very important; con...
focal length noun ... centre of a mirror or ...
focal point noun **1** a ... of interest or activity; ... the focal point for the ... became the focal point fo... ernment policy. **2** (technic...
focus /ˈfəʊkəs; AmE ˈfoʊ-/ ...
■ *verb* (**-s-** or **-ss-**) **1 ~** (**st...** attention, effort, etc. to one... or person rather than anoth... *on three main problems.* ◊ [V... *different grammar point.* ◊ [V... *world attention on the plight of...* **sb/sth**) (of your eyes, a came... adjusted so that things can be s... so that you can see things clearl... *on objects that are further away f...* *moments for her eyes to focus in th...* *the camera focuses on the actor's fac...* *blue eyes on her.* ◊ *I quickly focus...* *children.* **3** [VN] **~ sth** (**on sth**) (*tech...* light onto a particular point using a...
■ *noun* (*pl.* **fo·cuses** or **foci** /ˈfəʊsaɪ; ... usually sing.] **~** (**for/on sth**) the thi... people are most interested in; the act... attention to sth and making people inter... *the main* ***focus of attention*** *at the mee...* *ments provided a focus for debate.* ◊ *In to...* *focus will be on tax structures within...* ◊ *The incident brought the prob...* ***into*** *sharp* ***focus.*** ◊ *We sh...* *needs of the customer...* ***focus*** (= to look... **focal point**... an obj...

...ion rise and ... the water, using its ... as wings ... an animal like a mouse ... and eats fruit ... an officer of lower rank in the ... (officer Ian Wall ... a round spacecraft that some ... and that some people believe ... compare UFO ... (usually **the Flying Squad**) a group ... Britain who are ready to travel very ... of a serious crime ... frequent **flyer**) *noun* [sing.] a very ... competition, etc. IDM **get off to a** ... **a flyer** to make a very good ... *got off to a flying start in her*

... short visit ... **ves**) an empty page at ... *noun* **1** (*BrE*) (*AmE* ... road over another ... *noun* a special ... watch at an ... fabric on ... of the ... kilo- ... or


I. Background
Chapter 1.
Introduction
Chapter 2.
Concepts
Chapter 3.
Methods
II. Description
Chapter 4.
Emergence and
development of TCs
Chapter 5.
Demand for TCs
Chapter 6.
Supply of TCs
Chapter 7.
A compendium of TCs
III. Conclusions
Chapter 8.
Conclusions and recommendations

2. Concepts

2.1. Introduction

Why are technology campuses important? In order to answer this question, this chapter outlines the societal relevance of the built environment stimulating innovation in the context of the knowledge economy. As mentioned before, the knowledge economy is assumed as the relevant contemporary context influencing the strategic goals of the organisations involved in the development of technology campuses. Therefore, the reader of this review must take into account that the development of technology campuses is studied as a built environment phenomenon involving public and private organisations interested on stimulating innovation in the knowledge economy. The knowledge economy is often used as a concept in different fields of study. This review focuses on those theoretical notions used in urban studies, real estate and other related fields that can help to uncover the relationship between innovation and the built environment in this context.

2.2. Knowledge, innovation and the built environment

The meaning of knowledge has increased in complexity since today's economy is being referred as the knowledge-based economy. Related definitions of the knowledge-based economy have been elaborated in different fields from the second half of the 20th century up to date. The idea of knowledge as an economic factor is attributed to Schumpeter, who addressed the economic relevance of knowledge for innovation and entrepreneurship in 'The theory of economic development', first published 1912.

The idea of knowledge linked to economy has gained importance in the 1990s. A prominent business study (Porter, 1990) positioned the creation and assimilation of knowledge as basis of competition. In his study, Porter asserts that 'a nation's competitiveness depends on the capacity of its industry to innovate' (p. 73). This study gave to knowledge and innovation an economic significance at national level.

Similarly, an earlier viewpoint on knowledge as an economic resource comes from a management study addressing its importance for a so-called 'post-capitalist society' (Drucker, 1993). Accordingly, in this society –also called the knowledge society- the application of knowledge to work creates value through productivity and innovation. In his study, Drucker coined the term knowledge workers as to the leading social group of the knowledge society. In this context, knowledge as an essential societal resource puts the educated person in the centre of the system. Correspondingly, the importance of knowledge and innovation for the economy was sustained by a well-known study in social sciences, in which society is referred as the network society (Castells, 1996).

Soon, knowledge was put forward as the new source of competitive advantage in industrialised countries. According to Cooke and Leydesdorff (2006), the term knowledge-based economy has emerged as a required system perspective used by governments for developing science, technology and innovation policies. In policy, one of first definitions was addressed in an economic development report as 'the economies which are directly based on the production, distribution and use of knowledge and information' (OECD, 1996). In this document, knowledge is recognised as the driver of productivity and economic growth, leading to a new focus on the role of information, technology and learning in economic performance. In the same line, other development organisations manifested their interest on knowledge as central for society. For example,

The development of technology campuses is studied as a built environment phenomenon involving public and private organisations interested in stimulating innovation in the knowledge economy.

the World Bank released 'Knowledge for Development' in 1998 followed by the European Commission, which launched 'Innovation Policy in a knowledge-based economy' in 2000.

At regional level, some industrialised countries began focusing their attention on this matter. For example, the Department of Trade and Industry of the UK declared its position in a white paper by defining the knowledge economy as 'a new economy in which the generation and exploitation of knowledge has come to play a predominant part in the creation of wealth. It is not simply about pushing the frontiers of knowledge; it is about the most effective use and exploitation of all types of knowledge in all manner of economic activity' (DTI, 1998). In practice, few regions in Europe have already adopted knowledge-based policies and strategies. For example, the city of Delft has a deliberate knowledge-based strategy since the beginning of 1990 (Van Der Geest & Heuts, 2005).

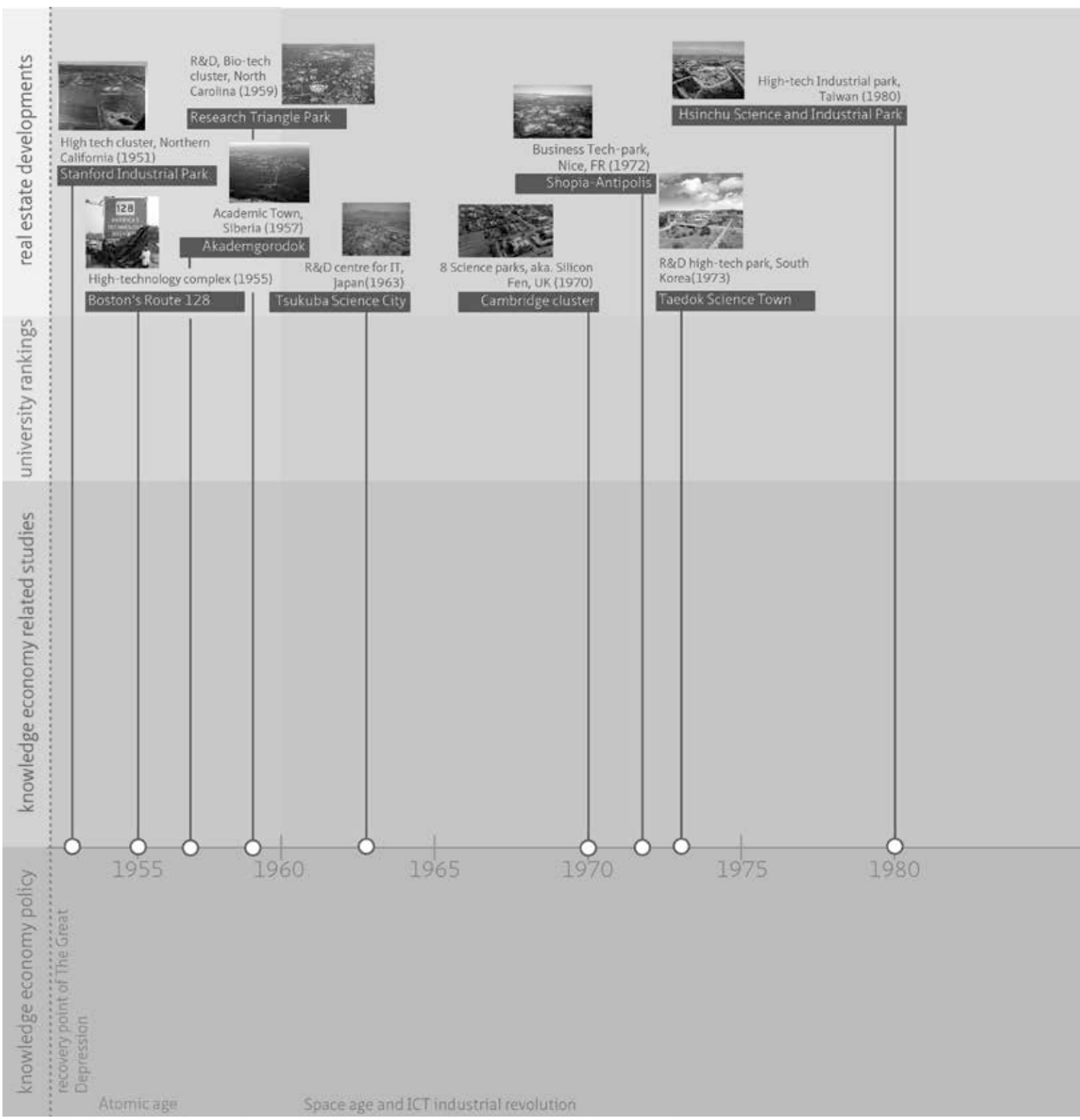
The focus of global policy on knowledge since 1996 has been calling the attention of many scholars in the urban domain since knowledge is mainly produced and exploited in cities. In academia, there has been an interest to outline the relevance of cities and regions shaping the dynamic of the knowledge economy. For instance, scholars in the field of economic geography (Bryson et al., 2000) focused on explaining the nexus between knowledge, space, and economy. They brought together the interdisciplinary work of scientists from a range of social sciences to emphasize the meaning of knowledge from a spatial perspective as a research agenda. Likewise, this study also recognises the need for continuous innovation and the importance of knowledge for competitive advantage in capitalist societies. Nevertheless, it brought a new perspective to explore the spatiality of the knowledge economy explaining agglomeration or clustering as a knowledge-based phenomenon, which contested the idea of globalisation diminishing the importance of geography in business.

Many of these and more notions were summarised in a well-known urban study outlining the role of cities in the knowledge economy (Van Den Berg et al., 2005). These researchers list a number of characteristics of the knowledge economy found in the literature, which are relevant to investigate its urban dimension. For instance, they argued that knowledge economy applies to all capitalist economies that depend on knowledge as crucial input. Furthermore, they emphasize the distinction made in previous researches between the various types of knowledge (tacit and codified), data (unstructured facts), and information (structured data). In this discussion, the individual 'knowledge worker' plays a central role embodying tacit knowledge, and using data and information in problem setting/solving. Herein, knowledge and information are recognised as the main inputs and outputs in the knowledge economy since the knowledge worker is continuously transforming these two into new knowledge and information. Additionally, innovation and entrepreneurship became major points of attention as source of competition because knowledge and information can be transformed into new and competitive businesses relevant for economic development. Likewise, the knowledge economy is recognised as a network economy because both, knowledge and information are difficult to appropriate due to globalisation and ICT advancements, which have increased their diffusion speed. Thus, networks enable people, companies,

or cities to share complementary knowledge resources in a fast changing environment. Last, these researchers discuss a socio-cultural dimension of this economy pinpointing the differences among countries in their transition path to a knowledge-based economy. This dimension raised questions about the role played by culture and social equality in the efficiency of the entire system.

According to these viewpoints, there are multiple and interdisciplinary approaches and notions that can be used to refer to a knowledge-based economy, which is increasingly complex to define. More detailed stands has grown over the last two decades referred as 'knowledge-based urban development' (KBUD), which focuses on the so-called 'knowledge city' or 'knowledge/learning region'. Both knowledge-based policies and urban studies have positioned universities as key players in this context because they educate the future knowledge worker. These institutions increasingly compete to attract a growing number of students in tertiary education. As a result, several university rankings have been created as instruments to compare the quality of knowledge in a global scale. Cities and regions increasingly use those as means of competitiveness. In the current economic context, the physical presence of universities and other higher education institutions are crucial to strengthen regional economies, especially in those regions that focus their economies on clusters development.

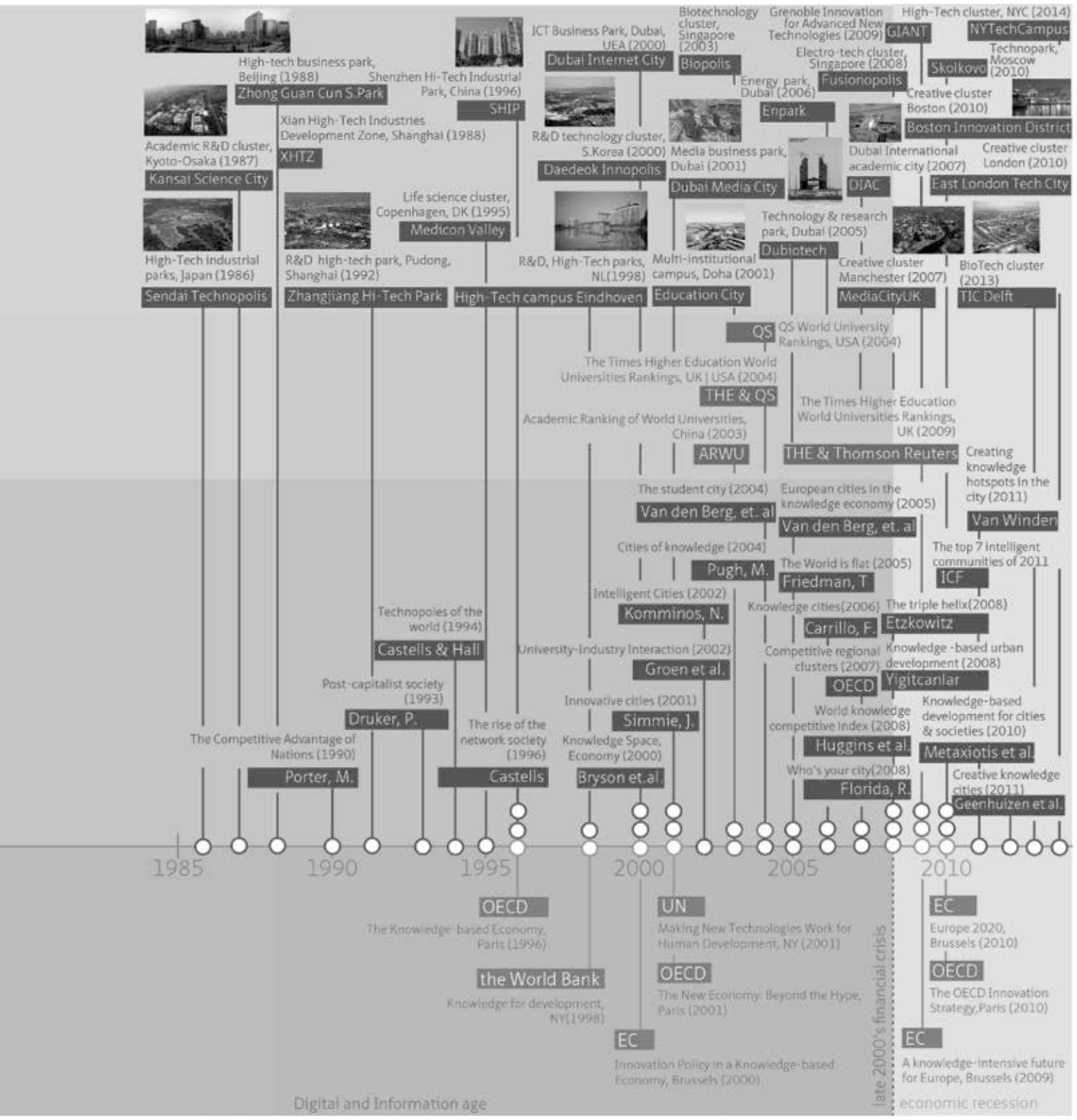
Generally, there is a co-evolving path outlining the importance of knowledge in studies, policies, and practices positioning innovation as main driver of competitiveness. However, when listing existing



built environments that have emerged to accommodate the creation and application of knowledge this study observed that a large number of them have emerged earlier than the so-called knowledge economy, and their popularity has increased in the last decades. These developments are related to earlier periods of technology advancements since the late 1940s, which have also influenced the meaning of knowledge as addressed in the literature (See Figure 2.1).

The following paragraphs aim to outline the deserved importance of the built environment in innovation in the context of the knowledge economy. First, it draws the attention towards cities as local contexts of technology campuses. And second, it outlines the roles and meanings of the built environment for the stakeholders involved in campus development in this context.

Fig.2.1 Overview of the different layers considered in this review of the literature as relevant for the development of technology campuses: knowledge related policy (grey), knowledge-based urban studies (red), knowledge driven instruments (blue), and knowledge-based real estate developments (green) (Curvelo Magdaniel, 2016)



2.2.1. Cities and the built environment in the knowledge economy

Knowledge is a source of urban competitiveness in the current economy. Cities and regions compete with each other to attracting and retaining high-skilled people. The ideal city in the knowledge economy is an 'attractive city' which is characterised by the concentration of human capital and the organisation of this capacity into productive outcomes. Accordingly, the following paragraphs highlight the most important features of cities in the knowledge economy as relevant for this research.

The knowledge city

The review of the literature has shown that the topic so-called 'knowledge city' is emergent and based in empirical approaches, which theoretical frameworks are interdisciplinary. In fact, its relations with theories of Economic Growth, Knowledge Management, Urban Studies, Planning, Geography and other social disciplines make 'the knowledge city' a complex topic, and therefore difficult to define especially in terms of scale. Indeed, this intrinsic link between city and economic growth -outlined by several researchers investigating the knowledge-based economy- has blurred its geographic scale. Several studies refer to the knowledge city as geographic areas where knowledge-based activities are taking place and influencing local economies in different ways. Accordingly, the scales of these areas range from knowledge hot spots (Van Winden, 2011) and knowledge precincts (Yigitcanlar et al., 2008) up to knowledge cities, regions or even mega-regions[5]. For instance, 'knowledge-based development' (KBD) is used in this analysis as a term that involves both socio-economic and spatial development studies in which the 'knowledge city' is related as economic and geographic unit in a broader sense.

As shown before in Figure 2.1, the diversity of studies reviewed in this exploratory research (e.g. academic research, policies, urban studies, institutional reports, etc.) illustrates the difficult task of establishing a common ground for the knowledge-city as topic because of the different approaches to it. For instance, some empirical studies focus on developing indicators in order to position the performance of cities in the competitive context of the knowledge economy. Other studies highlight the experiences of specific cities in the context of the knowledge economy based on initiatives and efforts by cities to include knowledge as a key aspect in their strategies. Although these studies differ in their approach, an important finding in this review is the relevance of the knowledge city as a global contemporary phenomenon in practice (See Figure 2.2)

It takes more than knowledge-based policies or strategies for cities to remain competitive in the knowledge economy.

Regardless its increasing attention in practice, the existing research about cities in the knowledge economy is immature in the literature (See Figure 2.3). For instance, the existing scientific ground is based on single or comparative case studies, mainly published as a collection of papers and with a focus on description of cities' experiences in adapting their transition to the knowledge-based economy (Carrillo, 2006; Groen & Sijde, 2002; Van Den Berg et al., 2005; Van Geenhuizen & Nijkamp, 2012; Van Winden, 2011; Yigitcanlar, 2008). Indeed, most of the cases studied focus on European cities of relatively small size (i.e. cities with a population of less than 500.000 inhabitants), with few exceptions of large cities in developing countries.

In this context, this review highlights a well-structured framework so-called 'the knowledge foundations and activities of the knowledge economy' (Van Den Berg et al., 2005) illustrated in Figure 2.4. This framework was developed to establish a comparative way to judge the performance of urban regions in the knowledge economy. It distinguishes foundations (structure) and activities (process) of the knowledge city facilitating the description and comparison between cases. Indeed, this framework was tested with nine cities across western Europe and has been validated with other cases in similar and different

Fig.2.2 Cities that identify themselves as knowledge cities and/or have strategic plans to become one (Data: Knowledge Cities and the Knowledge Cities Clearinghouse, 2009 in Curvelo Magdaniel, 2016)

[5] The term Mega-Regions is introduced by Florida (2008) who mapped 40 Mega-Regions of the world ranked by its population, economic activity, Innovation (patents), and the presence of star scientists.

Fig.2.3 Map of some of the existing studies on cities in the knowledge economy (Carrillo, 2006; Groen & Sijde, 2002; Van Den Berg et al., 2005; Van Winden, 2011). Each colour refers to a different study (Curvelo Magdaniel, 2016).

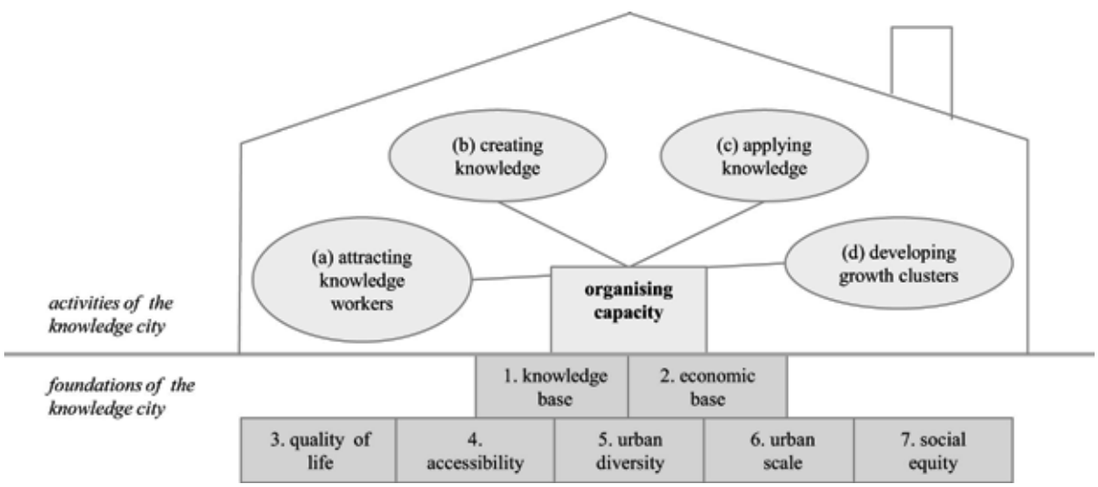


Fig.2.4 Foundations and activities of the knowledge city (Van Den Berg et al., 2005)

local contexts (Den Heijer & Curvelo Magdaniel, 2012; Van De Klundert & Van Winden, 2008). Overall, this work builds upon urban development studies balancing both the economic and spatial viewpoints of knowledge-based development, which could serve as basis to establish more specific links with the built environment and its role in the context of the knowledge economy.

The review of the literature on knowledge cities helped to identify a set of common patterns in cities and regions referred here as indicators of knowledge-based development (KBD). Those indicators distinguish two categories: internal and external indicators of KBD. The internal indicators are structural aspects of cities/regions that characterise a potential environment for KBD. The external indicators are the specific actions or initiatives these cities/regions are carrying out to succeed in adopting the knowledge-based economy (See Table 2.1). Accordingly, it takes more than knowledge-based policies or strategies for cities to remain competitive in the knowledge economy. Socio-economic development in the knowledge economy deals with many aspects such as governance (Lambooy, 2006), collaboration between key actors and networks (Fernández-Maldonado & Romein, 2012), the type of city managing its transition from industrial to knowledge-based activities (Van Winden, 2008), and other place-based aspects relevant for individuals (Fernández-Maldonado & Romein, 2008; Van Winden & Carvalho, 2008).

As shown in Table 2.1, only one indicator of KBD in cities/regions can be directly related with the built environment. Accordingly, 'large investments in the development of physical infrastructure where knowledge-based activities take place' (B.3) include the development of built environments such as technology campuses. In this matter, attention is given to locations accommodating the knowledge-based activities of universities, companies and other research institutes. The relevance of accommodating tech-based research is outlined in the following paragraphs.

A. INTERNAL INDICATORS STRUCTURE OF THE CITY-REGION: KBD POTENTIAL		B. EXTERNAL INDICATORS ACTIONS OF THE CITY-REGION: KBD OPPORTUNITIES	
A.1	Cities adapting new economic models and facing socio-economic transformation process. Indicator: Strategic vision on knowledge-based development as new joint identity.	B.1	Large investments on dedicated clusters with emphasis on specific growing industries that matches the local 'academic-business' climate and strengths.
A.2	Small to medium cities with population up to 1,0 ml inhabitants. Indicator: higher intensity of knowledge-based activities and available knowledge-based jobs.	B.2	Presence of incentive structures and incubator centres that promote entrepreneurship, start-ups and spin-offs from universities, R&D institutes and firms.
A.3	Large and well prepared student population. Indicator: Presence of large and/or top University or higher education institutes	B.3	Large investments in the development of physical infrastructure where knowledge-based activities take place.
A.4	Strong presence of diverse knowledge-based firms. Indicator: amount of R&D multinationals, innovative SMEs locally rooted at regional level and/or service & business sectors companies.	B.4	Public-private synergy and collaboration for planning and execution of knowledge-based strategies, programs and projects, involving at least two of the following actors: local and regional authorities, universities, private sectors and community.
A.5	Good connectivity and accessibility for traffic and public transport at regional, national and international levels. Indicator: proximity to airports and well-functioning mobility infrastructure	B.5	Leadership, active urban management and co-development networks.
A.6	Available ICT infrastructure ensuring digital access and social inclusion. Indicator: high broadband penetration and diffusion.	B.6	Explicit knowledge-based economy strategy with a strong orientation on a regional perspective (e.g. marketing strategy to communicate transformation processes) .
		B.7	Regional policy frameworks that support the development of all actions mentioned above.

Table 2.1 Collection of indicators of KBD in cities and regions based on the review of the literature

2.2.2. The built environment as infrastructure resource of the Triple Helix

Research is an essential knowledge-based activity for innovation, which increasingly involves the interaction between universities, R&D companies and governments. The university-industry-government relationship is also referred as the concept of the Triple Helix (Etzkowitz, 1993; Etzkowitz & Leydesdorff, 1995). Accordingly, this concept positions the hybrid role of universities, industry, and governments as crucial in the knowledge society because the potential for innovation and economic development resides in the capacity of these three spheres to generate new institutions and social formats for knowledge creation, diffusion and application.

The role of universities and higher education institutions have become prominent in this context since they are referred as the engines of the knowledge economy engaged in research and educating the future entrepreneurs (Etzkowitz, 2004). At regional level, the presence of universities potentially contributes to economic development (Drucker & Goldstein, 2007). This study summarises this impact through eight different functions of modern research universities: (1) creation of knowledge, (2) human-capital creation, (3) transfer of existing know-how, (4) technological innovation, (5) capital investment, (6) regional leadership, (7) knowledge infrastructure production, and (8) influence of regional milieu. This last function is particularly important because it refers to the unintentional effects of the presence of universities and their activities in their surroundings, which according to the authors deserve more attention in the literature (e.g. intellectual, social, cultural, or recreational dynamics by attracting a concentration of highly educated people at a particular location).

Creating a healthy and attractive social climate is key in the development of human capital in cities (and regions) as addressed in various urban studies (Drucker & Goldstein, 2007; Fernández-Maldonado & Romein, 2008; Van Den Berg et al., 2005). The human capital in the knowledge economy has been emphasised as source of economic growth in cities (Florida, 2002), urban competitiveness (Van Winden & Carvalho, 2008), regional innovation (Faggian & McCann, 2006, 2009) and national productivity growth (McCann, 2012). Accordingly, a city's capacity to attract and retain highly educated workers relates both to the quality of its knowledge base and to other aspects defining quality of life (e.g. housing, safety, cultural amenities, diversity, etc.).

Previous empirical research has shown that a relevant number of research universities (i.e. those providing PhD programs) are mostly concentrated in few regions around the globe and most of them are accommodated in inner city locations[6]. Correspondingly, they concentrate an important share of the human capital in urban regions (See Figure 2.5). These findings stress the role of universities' locations in the competitive profile of cities and regions in the knowledge economy because they bring high quality undergraduate human capital to a region. However, the mere presence of universities and their human capital is not enough to stimulate innovation and create wealth in cities.

Although there is research evidencing that co-location with top-tier universities promotes collaboration between universities, and high-research and development firms (Laursen et al., 2010), there are challenges for cities in exploiting and managing the provision of human capital as economic assets. Accordingly, managing the interaction between universities, industry and governments is the basis to remain competitive in the knowledge economy. This involves managing the relationships among stakeholders within each of these organisational spheres, which are place-based fostered. Cities and regions have the ability to optimise the cooperation between these spheres through different activities and at different levels (e.g. from strategic to operational).

[6] A pilot study conducted within a PhD research revealed the geographical distribution of what are considered sources of knowledge in the knowledge economy (Curvelo Magdaniel, 2016). Empirical data from public sources on the top 200 universities published in The Times Higher Education rankings was converted it into geographical information using ArcMap. It is observed that 63% of these universities are settled in inner city locations and 37% located outside cities. Also, 58% of the universities have multiple campuses. Therefore, 16% of the total settle both in urban and suburban areas. Additionally, it is observed that in Europe, large part of the knowledge clusters are located in medium to small cities (with population between 250.000 and less than a million inhabitants), with few exceptions such as London, Paris, Copenhagen, Dublin, Berlin and Munich). On the contrary, the knowledge clusters in Asia seem to be located in large metropolitan areas, while in USA they are in large, medium and small cities.

Fig.2.5 Concentration of human capital in number of students and academic staff in a sample of 200 universities according to The Times Higher Education Top University Rankings 2011-2012

A city's capacity to attract and retain highly educated workers relates both to the quality of its knowledge base and to other aspects defining quality of life (e.g. housing, safety, cultural amenities, diversity, etc.).

At operational level, investing in the development and management of physical infrastructure that supports the creation, diffusion and application of knowledge can be seen as a way to strengthen these relationships (Van Winden, 2008). For instance, these organisational spheres and the infrastructure that support their activities are regarded in global policies as national science systems[7]. Thus, the physical infrastructure -including the built environment- is an essential part of these systems, which is outlined in a general way as an enabler of innovation (Anderson et al., 2013; Florida, 2010). Florida (2010) outlines technology, education and transportation as large-scale system's infrastructure needed to support the current demands driven by innovation, velocity and flexibility. Similarly, this author regards the physical infrastructure as a resource-type of infrastructure that supplies a common supportive ground for these systems' infrastructure. An overview of the three systems and the role of the built environment can be summarized in Table 2.3.

Generally, the physical infrastructure comes to play a supportive role for these systems as an asset resource for urban competitiveness that can be used to target investments either in new infrastructure, expansion or efficient use of the existing one. Hence, building new- or investing on existing technology campuses can be seen as one of the resources that support these broad systems. Studying technology campuses as a research topic is connected with several contemporary issues beyond the built environment dimension. Although this dimension is small part of a broad range of social and economic transformations as seen in this section, the following paragraphs focus on outlining the relevance of the built environment as an organisational resource.

Table 2.3 Role of the built environment as resource supporting technology, education and transportation

SYSTEM'S INFRASTRUCTURE TO SUPPORT THE DEMANDS OF THE KNOWLEDGE ECONOMY	>> ROLE OF THE BUILT ENVIRONMENT
Technology. From the economic perspective, technological development has acted as enabler bringing powerful and general purpose ICT in today's economy. The application of science and invention to industry is nothing new but the accelerated speed of technological developments throughout the 20th century has resulted into a massive spur to productivity, enabling 'innovation' to emerge as the most valuable resource to recovery after crisis periods.	Innovation in the built environment should not been limited to the application of technology for the development of physical infrastructure. Instead, physical infrastructure is a crucial one that effectively supports two new types of infrastructures referred to as 'large-scale systems' innovation' for prosperity and growth: education and transportation (Florida, 2010).
Education. If the knowledge economy is based on the new technologies applied by highly educated people to create value within organisations, then human capital is essential for economic competitiveness. Hence, universities and the higher education institutions play key roles as economic actors attracting and retaining research and development into regions.	The physical infrastructure that supports higher education is becoming relevant. Recent research on university campuses (Den Heijer, 2011) addresses the crucial role of the built environment supporting the fulfilment of the primary function of the universities but also to support strategic goals such attracting and retaining talent. This view is supported by experts in economic geography (McCann, 1012) outlining the role of the universities' environments shaping the preferences of the future knowledge workers.
Transportation. New transportation systems not only have enabled cities to expand but people to commute long distance between home and work. As a result, the lifestyle of today's workers has evolved along with the transportation systems, which nowadays are more diverse and accessible, allowing faster regional and (inter) national connectivity.	The competitiveness among places grows as easier as talent moves and that implies the development of physical infrastructure that connects them.

[7] 'Public research laboratories and institutions of higher education are at the core of the science system, which more broadly includes government science ministries and research councils, certain enterprises and other private bodies, and supporting infrastructure'.(OECD, 1996).

2.3. Technology campuses as organisational resources

2.3.1. The strategic campus

Technology campuses are strategic resources of universities, firms and governments engaged in the accommodation of tech-based research activities. The knowledge economy –as the dynamic environment in which these organisations operate- is affecting their values and the ways they manage their resources including their properties. Universities and R&D companies as well as other research institutions have become major actors in this context because their core processes deal with research activities leading to the development of new technologies, services and products. These advancements determine the competitive advantage of cities and regions in today's' knowledge society[8]. Evidently, municipal, regional and national governments are actively encouraging (and sometimes directly involved in) the accommodation of research activities leading to these outputs. Most technology campuses have emerged and developed along the 20th century, specifically since the early 1950s, thorough different periods of technological advancements in industrialised countries. However, the ways in which these and other built environments began to be seen as organisational resources have developed in management theories since the early 1990s.

Certainly, one of the most influential concepts in the field of CREM/PREM is the one coining corporate real estate as 'the fifth resource' (Joroff et al., 1993). Accordingly, real estate is outlined as a facilitator of the primary processes of an organisation next to capital, human resources, information and technology. This approach established corporate real estate as a management field, whose changing role was described in five evolutionary stages that moves from a technical towards a strategic focus. In this approach, the 'alignment' between corporate and real estate strategies is central as well as the dynamic environment in which organisations operate.

Simultaneously, Nourse and Roulac (1993) worked in a corresponding strategic approach of corporate real estate management outlining the relevance of real estate decisions contributing to the realisation of the overall business objectives on an enterprise. Accordingly, the 'articulation' between real estate strategy and corporate business strategy is a precondition to make effective real estate decisions favouring an enterprise's business. This work pointed out that in obtaining such results managers must explicitly address how real estate strategies support corporate strategies. Furthermore, this study outlines that the driving force(s) of a company (in terms of products/ markets, capabilities, and results) determines the business direction of a company, which changes over time with changes in specific environments.

Accordingly, these two studies positioned the dynamic environment in which organisations operate as an influential context for 'alignment' between corporate and real estate strategy. This context and the particular culture and value of the organisations determine the appropriate real estate strategy or strategies that effectively support the broad business objectives of such organisations. From the CREM perspective, technology campuses are hybrids subjects of study in the sense that their developments involve the objectives of different organisations.

From the CREM perspective, technology campuses are hybrids subjects of study in the sense that their developments involve the objectives of different organisations.

Table 2.4 illustrates how these organisations might have similar driving forces (i.e. the creation of new knowledge and its application to develop new technologies) but different values and culture (i.e. the traditional mission of universities is to educate people and advance research for society, while R&D companies advance technologies targeted to yield return or profit). Outlining the role of technology campuses as organisational resources and considering their hybrid corporate real estate status increases the relevance and complexity of this research. That is because the driving forces of the involved organisations have also changed with the knowledge economy.

Another important aspect of managing a corporation's real estate portfolio is maintaining a balance between conflicting interests inside the organisation. According to Nourse and Roulac (1993) the implementation of real estate decisions involves negotiations between multiple parties, which have 'diverse objectives, resources, requirements and constrains'. These authors also outline that in these negotiations it is crucial for all the parties to identify their real interests in order to reach agreements when an explicit strategy is defined. Correspondingly, G. Dewulf et al. (2000) outline that balancing the conflicting interest inside an organisation requires different skills and activities.

This view is linked to a previous study that positions corporate real estate as a management field that deals with four domains or fields of focus within the organisation, connecting the demand and supply at both, strategic and operational levels (De Jonge, 1997). Further research linked these perspectives to specific stakeholders involved in real estate decision – i.e. policy makers, controllers, users, and technical managers (Den Heijer, 2006). These CREM models have been used as conceptual frameworks that facilitate the identification of the conflicting interest among the parties involved in the delineation and implementation of real estate strategies. A recent research on the management of university campuses (Den Heijer, 2011) expanded the application scope of these models by positioning in these four perspectives other relevant stakeholders outside the organisation and connecting organisational and physical scales (See Figure 2.6).

Correspondingly, an important question has been posed in previous research in the CREM field: 'How can we measure the effectiveness of real estate strategy on corporate strategy?' In studying technology campuses as organisational resources, the focus must be placed on some specific aspects of real estate decision stimulating innovation as an organisational goal. In the early 1990s, geography and interpersonal interaction between workers were considered two basic issues with implications for the business strategy of specific organisations. For example, the demand for physical proximity (or not) in real estate decisions such as location and workplace settings were critical for generic strategies in which competitive advantage -as described in cluster theories- determined the driving force of many organisations (Nourse & Roulac, 1993, pp. 478, 479). Today, competition is still shaping the driving forces of universities of technology, R&D firms and governments involved in the development of technology campuses. However, the dynamic context of the knowledge economy is making the role of physical proximity in competition increasingly complex and important.

[8] There are multiple indicators of innovation found through the literature distinguished as input- and output indicators (Curvelo Magdaniel, 2016). The significance of output indicators (e.g. patents, licensing, publications, prototypes, etc.) differs a lot according to the type of organisation for whom innovation is an essential driver (e.g. universities, companies, and municipal or regional governments). For instance, each organisation value and use indicators to measure attaining innovation (success or failure) in relation to its own core processes and aspirations. For example, the sales flowing from new products are more relevant for R&D firms as the amount of Nobel laureates are for universities, or the number of R&D spin-offs per square kilometre is for local governments.

ORGANISATIONS	Potential role(s) in campus development	Organisational objectives	Competitive driving force in the Knowledge economy
Universities and research institutions in technology	End-user Owner / Tenant Developer	Educate students and advance knowledge and research for the benefit of the society	Science & Technology
R&D and high-tech companies	End-user Owner / Tenant Developer	Support research and to apply new knowledge to develop new products and services for the profit of the company's business	Technology & Return/profit
Municipalities and regions	Developer Promoter	Support research for economic and societal development	Technology and Growth

Table 2.4 Organisations involved in the development of technology campuses. Note: competitive advantage is seen as dependent upon the exploitation of an organisation's internal resources and capabilities.

Managing the interaction between universities, industry and governments is the basis to remain competitive in the knowledge economy. Investing in the development and management of physical infrastructure that supports the creation, diffusion and application of knowledge can be seen as a way to strengthen their relationships.

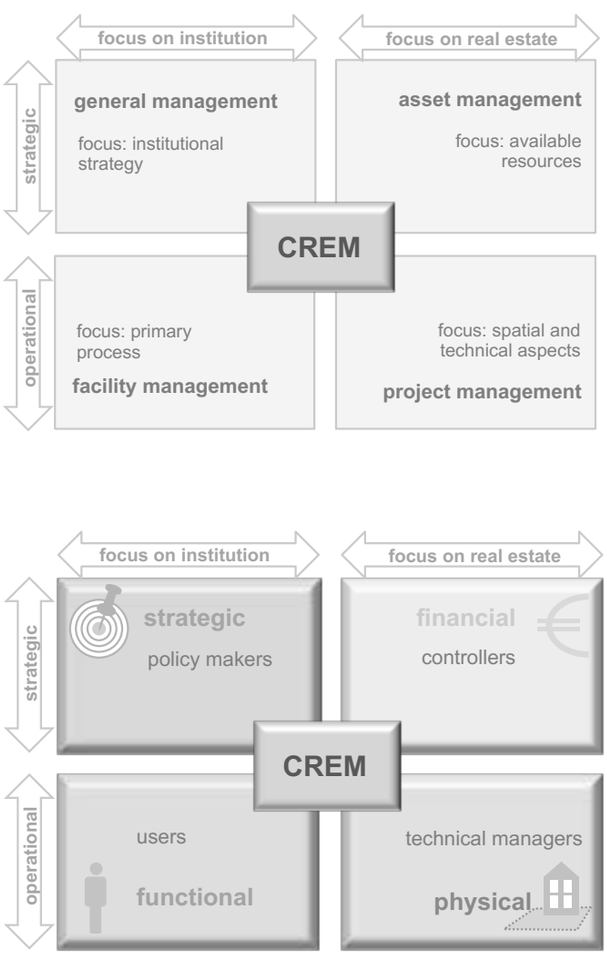


Fig.2.6 Comparing the CREM domains model (De Jonge, 1997) above, with the stakeholders model linked to the four CREM perspectives (Den Heijer, 2006) below.

This example reinforces the position that managing real estate has become managing the many uncertainties companies deal with when adapting to changes in their contexts. For instance, (1) the economy, (2) the user focus, (3) the dynamic between the functional, technical and economic lives of buildings, (4) the information technology, and (4) the environment are addressed as critical issues influencing the ways in which real estate should be managed (G. Dewulf et al., 2000). These -among other- aspects have been influencing the business environment of organisations, and therefore the ways of measuring the effectiveness of real estate strategy on corporate strategy.

In this theoretical context, the following three aspects determine the view of technology campuses as strategic organisational resources in stimulating innovation:

- The first is the hybrid corporate real estate status of the subject of study due to the different organisational objectives and values impacting decisions in technology campuses – i.e. Technology campuses are strategic resources that suggest alignment between real estate and multiple organisations at area level.
- The second is the dynamic context of the knowledge economy changing the competitive driving forces of the organisations involved in the development of technology campuses. For instance, an area to further explore in this literature is identifying the fundamental transformations of the knowledge economy affecting these organisations and the role of real estate in this context.
- And the third is the need for balancing the conflicting interests among internal and external stakeholders involved in the development of technology campuses. Campuses are large scale built environments that are an integral part of large physical and functional contexts (e.g. cities and regions).

The following section elaborates on the latter aspects.

2.3.2. The operational campus

In this study, the operational perspective of the built environment refers to the formal and functional structures of (the group of) buildings in a designated site, which are part of a context. Therefore, the operational campus is seen just as a physical and functional area in a city or region. Concepts from design and planning theories can be used to describe the supply of technology campuses. Simultaneously, these concepts can be associated with relevant topics of the context of technology clusters in the knowledge economy.

Form and function

Design theory on the built environment distinguishes several connotations of architectural form. From broad definitions such as 'the articulation between mass and space' (Bacon, 1974) to more concrete definition of elements that suggest reference and gives unity to the whole: Shape, Size, Colour, Texture, Position, Orientation and Visual Inertia (Ching, 1975). Being campuses a cluster of buildings in a site, more views towards built environment are being considered. Urban geography approaches on morphology (Kostof, 1991) considers basic components of 'town plan' such as the street pattern, the land use pattern (land parcels and lots) and the building fabric.

Existing study on campus design in North-American universities and colleges emphasizes the concept of 'place-marking' (Dober, 2003). Such study elaborates on a conceptual diagram outlining four important campus design factors: landmarks, materials, landscapes and styles. This study also outlines how 'campus design is itself the art of campus planning' (pp.3). In further studies, the same author defines campus planning as 'the premeditated guidance of the amount, quality and location of facilities for higher education so as to achieve a predetermined purpose' (Dober, 1996). Accordingly, the plan is illustrated as a physical form that already encompasses design characteristics in an area and a more or less detailed program. Furthermore, the physical form of the campus is listed in three orders of importance: a building, an outdoor space and the supporting site elements such as circulation.

In this context, form and function in large-scale built environments such as technology campuses are interrelated. Van den Voordt and Wegen (2005) discusses several functions of buildings including facilitating activities, protecting people against climate, expressing special meaning and adding economic value. They describe the first two as utility functions, which can be related to two of the four perspectives on campus management (Den Heijer, 2011):

- Supporting activities refers to the functional perspective from the users.
- The protecting function refers to the physical perspective from the technical manager.

According to Den Heijer (2011), these two corresponding perspectives focus on the supply side of real estate and can be used to describe the operational campus. Den Heijer (2011) uses variables in each such as the type and number of users in the functional perspective and the number of square meters in the physical perspective. Given the unique characteristics of technology campuses regarding their large-scale and multiple users, this study considers five main characteristics emphasizing the operational perspective of technology campuses: Location; Layout; Size and Density; Block pattern; and Appearance. These characteristics and their link to theoretical concepts relevant for this research are summarised in Table 2.5 and described as follows.

The operational campus is seen as a physical and functional area in a city or region

1) Location

This physical characteristic deals with the position of the campus in relation to its hosting city/region and other functional structures identified as relevant in this research. In campus planning the location is the geographic position of the physical area encompassed by the plan. The position of the campus in a city/region is linked to the concept of competitive advantage in research activities, which gives clusters a prominent role. Accordingly, the presence of interconnected companies, specialized suppliers, service providers, firms in interrelated industries and associated institutions in particular fields that compete but also cooperate suggests that much of the competitive advantage resides in the locations of a firm business unit (Porter, 1990).

Even though old reasons for clustering have diminished in importance with globalization, new roles of clusters in competition is gaining importance with an increasing, complex, knowledge-based, and dynamic economy (Porter, 2008). This view is supported by urban studies on the relevance of developing growth clusters as one of the crucial activities of the knowledge city (Van den Berg et al., 2005) addressing how business companies are more than ever tied to locations because they are dependent on highly-educated staff and on their integration into local networks. Similarly, the concepts of proximity, accessibility and connectivity to specific knowledge and social networks, linked to innovation, are widely discussed in several studies (McCann, 2007, Audretsch and Feldman, 1996, Breault, 2000, Laursen et al., 2010, Lagendijk and Lorentzen, 2007, Florida, 2010). For instance, the roles of effective transportation and mobility infrastructures are emphasised as relevant in some approaches because of the different geographical sources of knowledge networks.

2) Layout

This physical characteristic interrelates the spatial and functional ways in which the elements of the campus are arranged. Looking at the campus as an urban area but also as a portfolio, this research distinguishes the following as the elements of the campus: buildings and land. The last includes landscaped elements such as roads, squares, green and water. In theory of architectural form (Ching, 1975), clustered organisations such as campuses, group their forms according to functional requirements of size, shape, or proximity. Since the size and the shape of campuses' elements are very diverse, proximity of forms can be used to relate them to one another.

Herein, the concept of proximity gains relevance. Geographical proximity is believed to facilitate the flows of tacit knowledge[9] and the unplanned interactions that are critical parts of the innovation process (Europe INNOVA and PRO-INNO, 2008). These flows rely upon the willingness of firms to inform others about their knowledge, which depends upon the trust established between actors. This in turn can be facilitated through continuous face-to-face interaction. In this regard, a distinction is made about the multiple dimensions of the concept of proximity. In his critical assessment about Proximity and Innovation, Boschma (2005) distinguishes five dimensions of proximity: cognitive, organisational, social, institutional and geographical proximity. Accordingly, cognitive proximity is a prerequisite for interactive

[9] In order to facilitate economic analysis in the knowledge-based economy, tacit knowledge is categorised as a type of knowledge difficult to codify and measure. Referred as know-how (skills or capability to do something) and know-who (formation of special social relationships which make possible to get access to expert and use their knowledge specific) tacit knowledge have become increasingly important in the knowledge economy (OECD, 1996). Tacit knowledge is relevant then because is learned in situations and social practice. Therefore requires specialised environments and cannot be transferred through formal channels of information.

	FORMAL/FUNCTIONAL CHARACTERISTICS	LINKS WITH THEORETICAL CONCEPTS OF INNOVATION
1	Location and settlement	Clusters, Competitive advantage, Proximity, Connectivity, Accessibility.
2	Spatial and functional layout	Proximity (geographic, social and cognitive); face-to-face interaction; creativity
3	Size and Density	Social interaction, Proximity, Diversity (of people, ideas, buildings and functions).
4	Block pattern	Creativity; Small blocks and Chances of encounter and interaction; Diversity; Walk-ability; Accessibility
5	Appearance	Attractiveness of place; Added value of real estate (e.g. supporting image and culture)
Source	Theories on the built environment (Architecture, Urban planning, Urban design, Real Estate Management)	Literature review on the role of the built environment in innovation (Urban economy, Urban planning, Real Estate Management)

Table 2.5 Overview of the built environment characteristics of technology campuses in relation to relevant theoretical concepts linked to innovation.

learning processes to take place. The other four dimensions of proximity are considered mechanisms that might bring together actors within and between organisations. It is concluded that 'in theory, geographical proximity, combined with some level of cognitive proximity, is sufficient for interactive learning to take place'.

This wide perspective on the concept of proximity has been widely discussed in theory (Coenen et al., 2004, Boschma, 2005, Boschma and Frenken, 2006, Torre and Rallet, 2005, Boschma and Frenken, 2010, Lagendijk and Lorentzen, 2007). One of the most recent contributions of this debate argues that the types and levels of proximity, which are critical for knowledge networks, remains an unresolved question (Huber, 2012). This study examined spatial, social and cognitive proximity of personal knowledge relationships in a well-known Information Technology Cluster highlights the effects of spatial proximity. For instance, the findings of this study suggest that an important benefit of spatial proximity is that it enables knowledge flows with cognitively different actors.

Overall, the concept of geographical or spatial proximity can be seen as a practical intention in campus planning and design. Existing interpretations of intention attributed to form can be found in theory of urban form and design (Lynch, 1981). This study distinguishes three normative models related with the key motivation of the city arrangement. The first is the cosmic city as a spatial diagram of social hierarchy that is characterised by monumental axis, enclosure, hierarchical spaces and dominant landmarks. The second is the practical city as a functional construct of interrelated parts is made up of small, autonomous, undifferentiated parts, linked up into a great machine that has clearly differentiated functions. And the third is the organic city as an indivisible living organism that has a definite boundary and an optimum size, a cohesive, indivisible internal structure and a homologous morphology.

3) Size and density

These two are interrelated physical characteristics of technology campuses. In design theory, the size of the built environment refers to the physical dimensions (length, width and depth) which determine the proportions of the shape (Ching, 1975). In real estate management, this characteristic deals more in detail with the amount of space built or occupied in square meters. Accordingly, both approaches can be easily applied when describing the size of buildings types rather than site plans since the later consist of clusters of built environments. Thus, it can be said the size of technology campuses refer to the physical dimensions of the designated area in which the buildings are clustered. In other words, the shape of the land

Business companies are more than ever tied to locations because they are dependent on highly-educated staff and on their integration into local networks. The roles of effective transportation and mobility infrastructures are emphasised as relevant because of the different geographical sources of knowledge networks.

and the clustering of buildings in this shape determine the size of the campus. In that regard, the density of built environments in the land or the density of the cluster becomes relevant when defining the size of this type of built environments.

As mentioned above, clustered organisations such as campuses, group their forms according to functional requirements of size, shape, or proximity. Considering the relevance of proximity described in the previous section, the size of the land and the density of the built environments in campuses might have an influence on the functional and spatial arrangement when enabling social interaction through spatial proximity. Several studies outline the relevance of diversity (of people, ideas and functions) in cities promoting creativity, innovation and growth (Jacobs, 1961, Florida, 2002, Glaeser et al., 1992, Van den Berg et al., 2005). Indeed, Jacobs (1961) legitimized four spatial conditions generating diversity. These are (1) the need of primary mixed uses that ensures the presence of people who are able to use many facilities in common, (2) small blocks to increase the chances of encounter, (3) the mix of buildings varying in age and condition and so, in the economic yield they must produce, (4) and the dense concentration of people. In campuses, these four spatial conditions might also differ according to the size of the land and at the density of the built environments.

4) Block pattern

The shape and configuration of the streets and the buildings of the campuses determine this physical characteristic. This quality of the built environment is widely discusses in urban studies. In urban planning, the grid is outlined as the most common block pattern for planned cities in history (Kostof, 1991). Accordingly, this rectilinear planning solution is not only outlined as means for the equal distribution of the land or the easy parcelling and selling of real estate but its organisation is also attributed to politics and a sense of order in cities. Conversely, spontaneous cities underlines geomorphic, irregular, organic or non-geometric block patterns (Kostof, 1991). Accordingly, this pattern is presumed to be the resultant of the passage of time, the lay of the land, and the daily life of the citizens.

Another well-known pattern for planned cities is the so-called superblock, first introduced in the early industrial model villages in England (Kostof, 1991). The main idea of this block pattern is having houses looking inward toward a central green in which the traffic is excluded. Therefore, the houses are turned back on main streets and the conventional rectilinear grid was abandoned in favour of a curvilinear road scheme. This idea

The size of the land occupied by technology campuses and the density of their built areas might have an influence on the functional and spatial arrangement when enabling social interaction through spatial proximity.

became influential and was popularized by Ebenezer Howard with the model of the English Garden Cities. According to Kostof (1991), the most important patterns of this model were the independence of the building line from the street line and the rejection of the block system of the land division, which turned out into irregular blocks.

In the Modernist era, this idea of an in-turned superblock circumscribed by major traffic arteries was adopted, as a measure to reduce the volume and speed of traffic in urban areas caused by the increasing use of automobiles. Therefore, the provision of 'cul-de-sac' as part of the street hierarchy became essential in this planning pattern. The so-called Modernist superblock used the grid as a frame but instead of an organising pattern, it was used to separate communities. This planning pattern find inspiration in theories in modern architecture in which free-standing buildings set in a green area organised by a loose- maxi grid of high speed arteries became popular in American cities. These ideas evolved on 'The Radiant City' (Corbusier, 1935). Le Corbusier's plan, also known as 'Towers in the Park,' proposed exactly that: numerous high-rise buildings each surrounded by green space. Each building was set on the so-called superblocks and the space was clearly delineated between different uses including 'housing,' the 'business centre,' 'factories' and 'warehouses'. The influence of this planning approach in American neighbourhoods is also critically referred as the Invisible Superblock (Whiting, 2006). Both theoretical models - the Garden City and the Radiant City- used the superblock as main pattern criticise the use of the land for streets. Instead, the theorists of these models wanted land to consolidate into green and therefore, minimise 'wasteful' streets in cities. This idea is later referred as a destructive myth (Jacobs, 1961) explaining its reasons for much stagnation and failure.

Regarding the latter, a new planning perspective gained importance in the second half of the 20th century. The need for small blocks was legitimised by Jane Jacobs (1961) as one the spatial conditions that generates diversity in cities promoting creativity, innovation and growth. Accordingly, small blocks, more streets that are frequent and opportunities to turn corners, increase the chances of encounter. The author also outline the hindering social and economic effects of isolated and discrete street neighbourhoods hindering the potential advantages that cities offer to incubation, experimentation, and many small or special enterprises, as these depend upon the cross-use among users of a city neighbourhood. Therefore, frequent streets and short blocks become valuable but the growth of diversity only works attracting mixtures of users along then. In this way, small block pattern and the mixture of primary use are outlined as inextricably related.

Currently, the debate about the size of the block patterns and its effect is enduring in city planning. A recent journalism approach (Prize, 2013) emphasizes the relevance of the grid layout and the effect of different street widths and block sizes on land usage and walk-ability. Accordingly, the trade-off with the grid layout is choosing between walk-ability (small, finely grained blocks) or efficiency (large blocks, with very few streets).

According to Jacobs (1961), frequent streets and short blocks become valuable but the growth of diversity only works attracting mixtures of users along then. In this way, small block pattern and the mixture of primary use are outlined as inextricably related.

5) Appearance

This physical characteristic refers to the aspects defining the visibility or image of the built environment characteristics described above. These aspects could be associated with tangible features such as the materials of buildings, public space, landscape, etc., in which the design and construction quality play a key role. However, they can also be associated with the way those tangible elements are perceived by observers, which brings a degree of subjectivity in the definition of this aspect.

In this context, a well-known urban design theory, The Image of the City (Lynch, 1960), seeks for an objective reasoning of those aspects. Accordingly, there is a single public image of the city, articulated through the interrelation of five elements: paths, edges, districts, nodes and landmarks. These elements outline the relevance of several aspects in mobility patterns. For instance, the concentration of activities, character of specific areas, the presence of references, façade characteristics, proximity to special features of the city, visual exposure and prominence, building types, textures, materials, topography or people, among others. These aspects together in a context provide a specific identity to these elements and help to strengthen the image the city.

Notwithstanding, there is still a subjective connotation in appearance, which is attributed to the observers' perception when defining such image. In real estate management, supporting image is related to one of the added values of real estate to realise the objectives of an organisation (De Jonge, 1996, De Vries, 2007, Lindholm et al., 2006, Lindholm and Luoma, 2008). Accordingly, the appearance of real estate helps to strengthen organisational identity. Similarly, this added value has been study in university campuses (Den Heijer, 2011, Den Heijer and De Vries, 2004) outlining the relevance of 'real estate interventions that either support the image to the current users, external parties, or potential employees, for instance emphasizing the innovative, creative, sustainable or exclusive character of an organisation'. Besides, 'supporting image' is closely related to 'supporting culture' as another added value of real estate, which focuses on the internal users by means of building community, or stimulating interaction between groups of users matching the organisational culture.

This latter approach, which involves the supporting role of image not only at organisational level but also from the user's perspective, is relevant when addressing the need for attracting and retaining talent for growth in cities. Research clusters such as universities have emerged not only as engines to attract knowledge workers but also as engines of urban transformations (McCann, 2012). Accordingly, the built environment in which the future knowledge workers develop is shaping their consumption preferences. Current studies (Groot et al., 2011) research cultural factors and consumer preferences as ways to understand why clustering takes place rather than the traditional production type of externalities considered as relevant. Accordingly, it is crucial to understand to what extent locating the different types and characteristics of the amenities cities may offer drive behaviour of people. This approach is supported by similar studies (Faggian and McCann, 2009, Florida, 2008, Glaeser et al., 1992) which insights can be interpreted at the level of the built environment supporting a specific culture of knowledge workers. For instance, the role of green, mix of functions, building style, workplace layout, just to mention few of them, might differ from users' preferences and organisational cultures in technology campuses.

Overall, the appearance of these sites gains importance as a way to perceive the built environment characteristics in relation to the distinctiveness of technology campuses, supporting organisations' and users' image and culture.

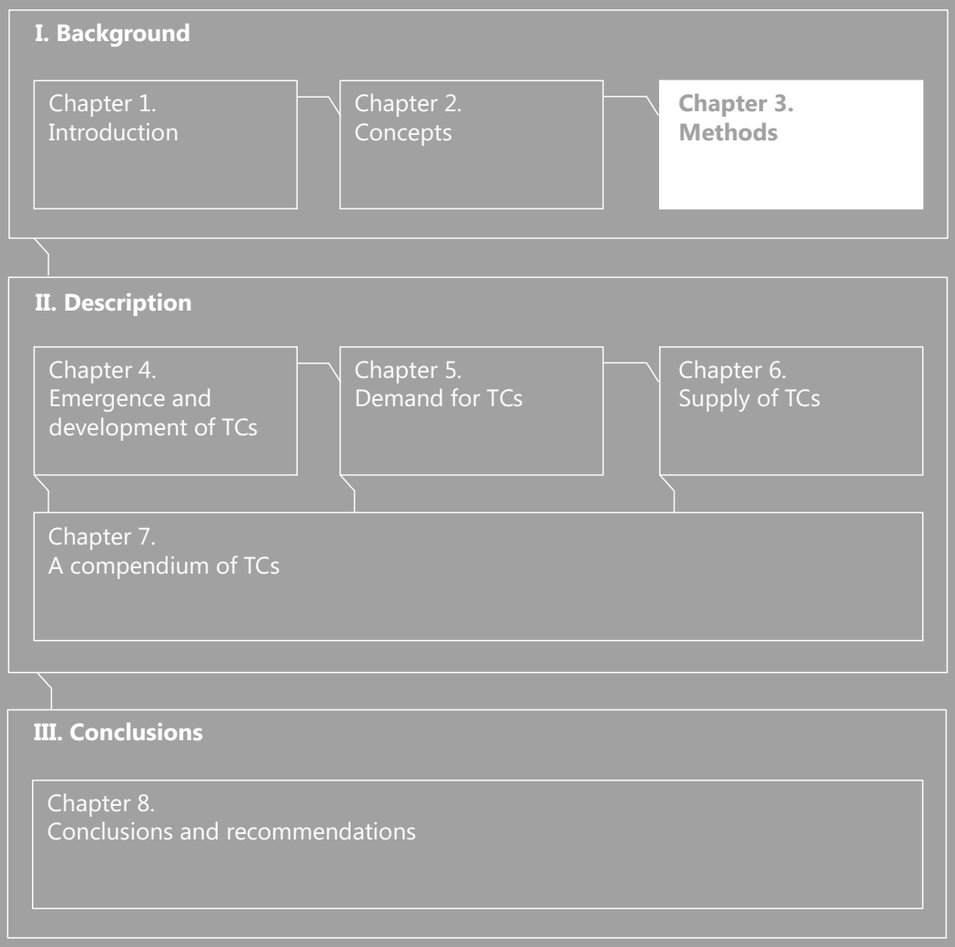
'Supporting image' is closely related to 'supporting culture' as another added value of real estate, which focuses on the internal users by means of building community, or stimulating interaction between groups of users matching the organisational culture. The role of green, mix of functions, building style, workplace layout, just to mention few of them, might differ from users' preferences and organisational cultures in technology campuses.

2.4. Chapter conclusions

This literature review has established scientific links between different fields addressing the contemporary relevance of technology campuses for innovation. On the urban side, it has shown that both socio-economic and spatial aspects are integrated in the concept of knowledge-based development (KBD). Cities and regions are considered the geographic units supporting the production of knowledge and where the interaction of relevant stakeholders enabling this process takes place. The built environment is an essential part of the entire KBD system because it shapes the city and accommodates the production of knowledge.

In turn, major shifts in economic structures and ICT developments related to KBD have had specific impacts on the built environment and its management at different scale levels. At building level, the changing ways of doing research call for different approaches in the provision of workplaces in both, academic and industrial environments. At area level, there is a demand for concentrating research activities in close proximity to specific organisations and places. Last, the involvement of various stakeholders with their different interests on innovation at urban and regional level poses interesting and challenging questions about the governance of these areas.

On the real estate side, this chapter has provided a way of understanding technology campuses as strategic and operational assets for organisations. Technology campuses are described in these terms and in relation to concepts from design and planning theories on the one hand and innovation topics in urban economy on the other hand. This multidisciplinary view of technology campuses is used to outline its relevance in the contemporary context and to develop a conceptual framework to describe them. The following chapter discusses how to do so.


I. Background
Chapter 1.
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Concepts
Chapter 3.
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II. Description
Chapter 4.
Emergence and
development of TCs
Chapter 5.
Demand for TCs
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Conclusions and recommendations

3. Methods

3.1. Introduction

How to describe technology campuses? This chapter answers this question by using qualitative survey of 39 international cases. This survey, conducted in 2013, is used to fill an empirical gap on the subject of study 'the development of technology campuses as built environments' (See Table 3.1). Accordingly, this survey studied the diversity of technology campuses and their hosting cities with the purpose of description. Through this method, the variety of built environments referred as technology campuses was explored, described, and compared. Since campus development is the subject under examination, this qualitative survey used documentation analysis rather than questionnaires for data collection.

This method is rather unfamiliar in social research methods compared with the well-known statistical survey (Jansen, 2010). Accordingly, a qualitative survey studies the diversity (not the distribution) of a population with the purpose of description. Insights from the review of the literature described in the previous chapter have been used to scan, select and analyse the subjects of study. The design of this empirical research in relation to the theory is illustrated in Figure 3.1.

OVERVIEW QUALITATIVE SURVEY	
Starting point	Knowledge gap about technology campuses from their built environment perspective.
Objective	Uncovering and describing the general patterns in the demand for- and the supply of technology campuses in an international context.
Subject or unit of analysis	Technology campuses in their hosting city/region
Object or analytical frame	The built environment as resources enabling the activities of- and supporting the goals of organisations.
Guiding question	What are the distinct characteristics of technology campuses from the built environment perspective?
Sub-questions	What are technology campuses? When and where did technology campuses emerge and develop? Are there evident patterns in their emergence and development? Who are the stakeholders involved in the development of technology campuses? What are their goals? Are there common patterns in the supply of technology campuses? What characteristics define the supply of technology campuses?
Relevant readings about the subject investigated	Castells, M, & Hall, P. (1994). Technopoles of the World. London Routledge. Carvalho, Luis. (2013). Knowledge Locations in Cities. Emergence and development dynamics. (Doctor), Erasmus University Rotterdam, Rotterdam. Hoeger, Kerstin, & Christiaanse, Kees. (2007). Campus and the City - Urban Design for the Knowledge Society (K. Hoeger & K. Christiaanse Eds.). Zürich: gta Verlag. Link, Albert N., & Scott, John T. (2003). U.S. science parks: the diffusion of an innovation and its effects on the academic missions of universities. International Journal of Industrial Organization, 21. Link, Albert N., & Scott, John T. (2006). U.S. university research parks. Journal of Productivity Analysis, 25(1-2), 13.

Table 3.1 Qualitative survey overview

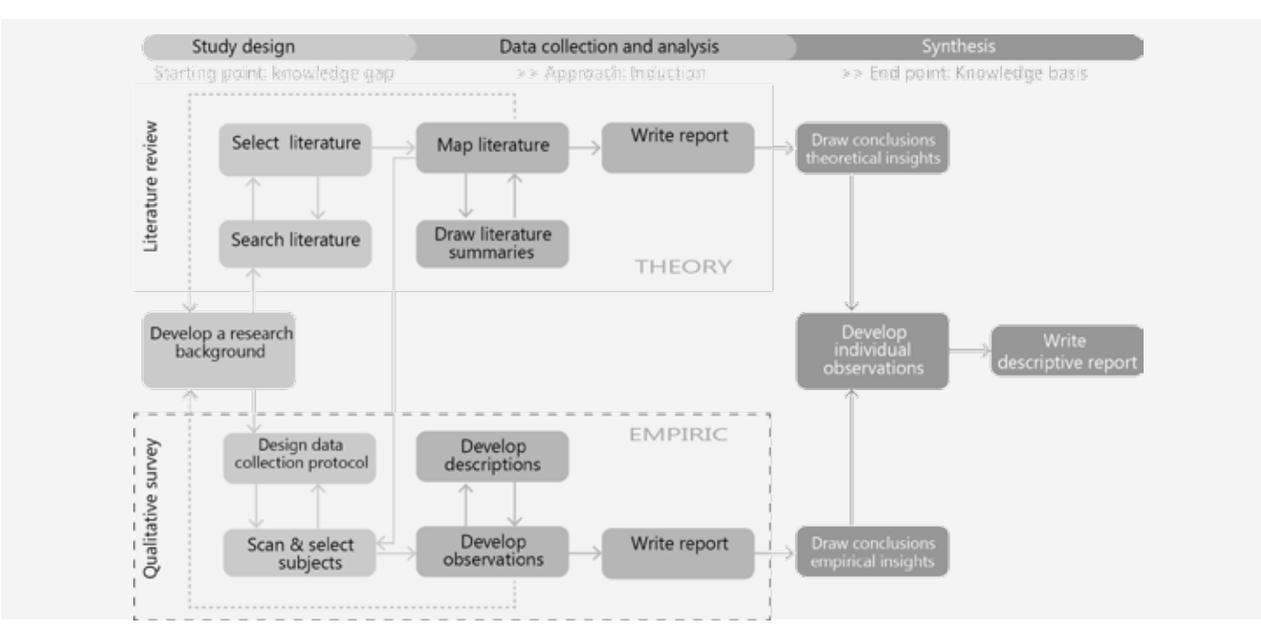


Fig.3.1 Study methods and phases. The focus of this chapter is encircled outlining the qualitative survey as main method of data collection and analysis.

3.2. Data collection procedures

3.2.1. Sample scan

This survey describes and compares a sample of thirty-nine technology campuses (See table 3.2) selected from more than fifty subjects listed through the review of the literature and other non-academic sources (e.g. newspapers, magazine articles, etc.). This selection is based on the consistency and availability of information documented about the subjects, both in existing research and in public documents from primary sources.

The amount of subjects in this sample is aimed to be representative of the diversity of built environments matching the preliminary definition of technology campuses. Accordingly, these are built environments that have been deliberately developed to accommodate technology-based research as core activity of specific organisations. In this context, the existing number of built environments matching this definition is unknown. However, and estimation of more than 700 is made based on the amount of science parks (>400) registered with International Association of Science parks (IASP); research parks (>700) registered with the Association of University Research Parks (AURP); and campuses of universities and colleges of technology (>200) included in university rankings (The Times Higher Education University rankings). Overall, the sample is built based on a scan of cases meeting the criteria in Table 3.3.

NR.	CODE	NAME SUBJECT	NAME CITY - REGION
1	SRP	Stanford Research Park	Palo Alto, California, USA
2	CBTP	Cornell Business & Technology park	Ithaca, New York, USA
3	TUESP	TU/e Science Park	Eindhoven, North Brabant, NL
4	AAT	Akademgorodok Academic Town	Novosibirsk, Siberia, RU
5	RCG-TUM	Research Campus Garching - Technical University of Munich	Garching, Munich Metro Region, DE
6	RTP	Research Triangle Park	The 'Triangle region' between Durham, Raleigh, and Chapel Hill, North Carolina, USA
7	ETHSC	ETH Hönggerberg Science City	Zurich, Zurich, CH
8	MIT - UP	MIT Campus & University Park at MIT	Cambridge, Massachusetts, USA
9	DCUT	Drienerlo Campus University of Twente & The Innovation Campus Kennispark Twente	Enschede, Overijssel, NL
10	TUDTIC	TU Delft District & Technopolis and Innovation Campus Delft	Delft, South Holland, NL
11	TSC	Tsukuba Science City	Tsukuba, Ibaraki, JP
12	CSP	Cambridge Science Park	Cambridge, Cambridgeshire, UK
13	SAP	Sophia-Antipolis Park	Côte d'Azur Region, FR
14	TST	Taedok Science Town & Daedeok Innopolis	Daejeon, Hoseo, KR
15	HSP	Hsinchu Science and Industrial Park	Hsinchu City, Northwestern Taiwan, TW
16	SSP	Singapore Science Park	Singapore City-State, SG
17	LBSP	Leiden Bio Science Park	Leiden, South Holland, NL
18	SYRP	Surrey Research Park	Guildford, Surrey, UK
19	WATP	Western Australia Technology Park	Perth, Western Australia, AU
20	OSP	Otaniemi Science Park & Otaniemi Technology Hub	Espoo, Greater Helsinki, FI
21	ST-IPT	Sendai Technopolis & Izumi Park Town Industrial Park	Sendai city, Miyagi prefecture, JP
22	KSC	Kansai Science City	Kansai [unincorporated city], JP
23	ZGCSP	Zhong Guan Cun Science Park	Beijing, CN
24	TPUB	Technology Park Bremen & University of Bremen	Bremen, Bremen, DE
25	BTUC	Brandenburg Technical University Campus	Cottbus, Brandenburg, DE
26	ZJHTP	Zhangjiang Hi-Tech Park	Shanghai, CN
27	TP	Taguspark	Lisbon, PT
28	BAHU	Berlin Adlershof Humboldt University	Berlin, Brandenburg, DE
29	SHIP	Shenzhen Hi-Tech Industrial Park	Shenzhen, CN
30	TSP	Tainan Science Park	Tainan City, TW
31	HTCE	High-Tech Campus Eindhoven	Eindhoven, North Brabant, NL
32	SPA	Science Park Amsterdam	Amsterdam, North Holland, NL
33	BPS	Biopolis	Singapore City-State, SG
34	TCSP	Taichung Science Park	Taichung,Central Taiwan, TW
35	BP	Biocant Park	Cantanhede, Coimbra, PT
36	CRDP	Chemelot Campus	Sittard-Geleen, Limburg, NL
37	BCK	Barcelona City of Knowledge	Barcelona, Catalonia, ES
38	GIANT	GIANT Innovation Campus (Grenoble Innovation for Advanced New Technologies)	Grenoble, Isère, Rhône-Alpes, FR
39	RWTH-RCM	RWTH Aachen University -Research Campus Metalen [expansion]	Aachen, North Rhine-Westphalia, DE

Table 3.2 List of technology campuses selected for this qualitative survey

CRITERIA	DESCRIPTION
1. Geography	Campuses in different regions of the world that allows an international comparison
2. Time	Campuses that emerged and/or have experienced significant physical changes during and after the post-WWII period, recognised in this research, as the historic periods of major technological developments up today.
3. Data availability	Campuses already built and documented in previous empirical researches and/or in official primary sources (e.g. institutional documents and websites), which are able to be located in open source maps.
4. Subject (option 1)	Campuses of universities of technology meeting the two previous criteria.
5. Subject (option 2)	Campuses that accommodate technology-driven research activities carried out by more than one organisation (e.g. more than one company and/or institute), considering the relevance of 'tech-based research' as an activity that increasingly involves the interaction of government, industry and universities.

Table 3.3 Criteria for selecting comparable technology campuses

3.2.2. Data collection plan

This study employed two main sources for data collection (See Table 3.4). First, it used document analysis of public records (e.g. mission statements, annual reports, policy, strategic plans, existing empirical research on the cases, maps, plans, photography, among others). Second, it used web-based databases and software (e.g. Google Maps, Google Earth, Arc Map, iTouchMap, etc.) to document the existing built realm of technology campuses.

A preliminary definition of technology campuses distinguishes them as built environments that have been deliberately developed to accommodate technology-based research as core activity of specific organisations.

3.2.3. Data analysis

In order to have an integral description of technology campuses as built environments, this study uses an approach from CREM/PREM theories (Figure 3.2), by which campuses are seen as real estate objects from four different perspectives: strategic, financial, functional, and physical. Similarly, the city is seen as the strategic, economic, functional, and physical context of campuses.

Based on this framework, the data is classified in four sets (strategic, financial, functional, and physical data) next to an additional set of general data. This classification was used to store the data in a computer database (with spread sheet applications), which formed an inventory of campus information. In order to make this data uniform, categories are distinguished in the inventory due to the diverse ways in which public data is presented by different institutions, scholars, or organisations. An overview of the data collected, inventoried, and controlled is summarised in the following tables (Table 3.5 to Table 3.9)

The data in each of to the four perspectives was examined in the search for emerging patterns. Although the analysis of the data is mainly inductive, the sampling and data collection was not entirely open but rather semi-structured. The identification of characteristics was guided by a structured protocol that distinguished predefined categories by using an approach from corporate real estate management. Some specific data was also informed by the literature review described in Chapter 2.

This organisation system, based on predefined categories, helped to develop observations from the data. Simultaneously, the observations are described by means of two main techniques according to the type of content described. For instance, mapping is used to illustrate spatial data while categorisation is used to read the connections between all spatial, numeric, and non-numeric data collected.

Then, by moving back and forth between observations and descriptions, this process culminates with developing general conclusions that could logically explain the emergent patterns. These conclusions are reported as main findings in the following chapter.

	DATA COLLECTION PLAN		
	SOURCES	EVIDENCE COLLECTED	PERIOD
Type 1: Document analysis	Academic (e.g. journal papers, books, empirical studies, and other scholar reports)	Broad-coverage information of the subject of study, with facts, details of events, and references of the subject of study.	2013
	Non-academic (e.g. journalism, institutional, governmental, educational, and other public records)	Exact information containing facts, names, references, and details of the subjects of study.	
Type 2: Web-based analysis from open access mapping applications	Google Maps	Specific information containing spatial data regarding the accessibility and connectivity of the subjects of study	2013 & 2017
	Google Earth	Exact information containing details of the physical developments of the campus in different time periods–imagery over time	2013
	Arc Map	Base maps used to confirm data collected	
	iTouchMap	Geographic coordinates of the subjects of study	

Table 3.4 Sources and evidence in the data collection process

CREM perspectives	Strategic	Functional	Financial	Physical
CREM domains	General management	Facility management	Asset Management	Project management
Stakeholders	Policy makers	Users	Controllers	Technical managers

Fig.3.2 Conceptual framework for data collection and analysis outlining stakeholders linked to the four perspectives on CREM (Den Heijer, 2006) and CREM domains (De Jonge 1997).

GENERAL DATA This refers to the data used to identify both the objects and their contexts	
Code	Based on the campus name and listing position according to the year
Year	Year of emergence (opening) and/or year in which significant physical changes has taken place (e.g. implementation of Master Plan; start of redevelopment)
Name campus	Official designation as appear in documented sources
Name city	Specific location addressing city, state/region, and country
Description	Brief introduction outlining where the campus are located, their profile or way they are regarded (known-for); the way they have been established if available.
Official designation of the campus	Three categories are distinguished: (1) Permanent: campuses that have kept the same name since their foundation, (2) Changed: campuses that accommodate changing end-users in relation with transitions in their profiles, and (3) In transition: campuses that are part of current or recent project which has a different name and are referred interchangeable as both denominations.
Geographic coordinates	The official address of the campuses available in their websites is converted into Latitude (X) and Longitude (Y) points by using an open access online application (iTouchMap.com. Mobile and desktop maps). Information displayed on the application is based on content provided by Google, the U.S. Geological Survey and National Geospatial-Intelligence Agency.
Cluster base campus	The industries represented in the campuses differ according the type of research clusters. Three categories of research are addressed: (1) Scientific or fundamental research, (2) Research and development, and (3) Research and development in combination with production.
Economic base of cities	The industries represented in the economic profile of the city. Three categories of data are identified: (1) Consolidated sectors/industries: descriptive data with facts of most representative industries in the economy, (2) Emergent sectors: descriptive data with facts of growing sectors, and (3) Key sectors: descriptive data without facts on priority areas for focus. This category emerged since in many cases, cities outline what they want to become rather than what they actually are.

Table 3.5 Overview and description of data classified as 'General'

STRATEGIC DATA This refers to the qualitative information focusing on institutional strategy (i.e. information through which campuses and cities identify and promote themselves, through institutional and/or official documents over time)	
Vision campus and Vision City	Based on the diversity of the data collected, the following four categories are identified and organised by their degree of specificity outlining a strategy: (V1) Policy, Strategy or Plan: the name of the specific instrument were the vision of the cities and institutions are contained if available, (V2) Ambition and/or Goals: the general aim and/or specific aims containing in a vision if available, (V3) Concepts and/or Pillars: the core elements throughout the vision is implemented, and (V4) Motto or Slogan: the official words used to identify the core of the vision on their documents or websites.

Table 3.6 Overview and description of data classified as 'Strategic'

FINANCIAL DATA This refers to qualitative data about the stakeholders investing and steering capital resources in the development of the campus (e.g. key development actors, and/or development partners).	
Campus Funding	Three types of funding are distinguished to identify the ownership and governing structures of technology campuses: (1) Public, (2) Private, and (3) PPP-Public Private Partnership. Nevertheless, when the objects have both public and private funding but a partnership is not officially established, it is outlined as (3a) PP. In cases that have changed their funding structures, the original type of funding is addressed by adding 'Changed' to their classification.
Campus Controllers	These are the advisory and management structures understood as a 'Stewardship that embodies the responsible planning and management of property resources'. This entity is distinguished as the campus manager.
City promoters	These are partners in campus development. Two types of promoters are distinguished: (Prom1) Official Promoter - the external stakeholders who are actively and formally marketing the campus. In some cases, these stakeholders are involved in campus decisions related to the provision of physical infrastructure in the vicinities of the campus. (Prom 2) Unofficial Promoters - the external stakeholders who informally market the campus as a positive brand for the economic development of the city.

Table 3.7 Overview and description of data classified as 'Financial'

FUNCTIONAL DATA This refers to quantitative and qualitative data about the users of the campus in the context of the knowledge economy. It distinguishes several fields to identify different types and sizes of users and functions accommodated on the campus and its hosting city	
Population campus	The size of the population on the campus. Two main categories of population groups are identified: (P1) Employees: workers and/or staff including academic staff, and (P2) Student: in Bachelor, Master and PhD levels. In the case this data is not found, it is replaced by the data available and categorised as 'Other'.
Population City	The size of the population in the city hosting the campus. The data is collected in most of the cases using the last census or the estimates published by the official statistics bureau of each city.
Organisations campus	The number and diversity of end-users' organisations accommodated in campus. There is a distinction on the type of end-users of the campus in three main categories: (O1) Companies: firms or multinational corporations (O2) Academic institutes: faculties, research institutes, and/or offices linked to a university and/or a higher education institution, and (O3) Other Institutes: research centres and institutes. In some cases, universities are part of these research institutes. The total number of organisations is an approximated number estimated on the amount of firms, the amount of the universities or HEI -without considering their institutes, departments or faculties separately; and the amount of other institutes.
Employment City	The size of the population employed in the city. The data focuses on the number of jobs and employed people. If available, the data includes the main employers by staff or by sectors. In the case this data is not found, it is replaced by the data available and indicated as '*' (e.g. percentage of employed population; unemployment rate; active staff, etc.). The data also varies from each region and their ways of measurement.
Tertiary Education City	Quantitative data on the academic knowledge base existing in the city where campuses are located. This field distinguishes two categories: (U) Universities and (HEI) Higher education institutions (e.g. colleges and other institutes that are not regarded as universities). The education systems vary from each region and so the different layers of tertiary education. A distinction in some universities is made outlining their respective rank number as 'R' by crossing data from a previous analysis that used the Top 200 universities (The Higher Education University Rankings 2011-2012).
Campus Amenities	Overview of the variety in the complementary functional space available on the campus besides those accommodating research as core activity (e.g. offices, labs or academic space). Three main categories are distinguished: (F1) Shared facilities: mixed uses in one single facility (F2) Green & Sport facilities: sport halls and courts, landscape features, etc., and (F3) Residential & Care facilities: housing, hotels, day-care, supermarkets, etc. When these functions are planned and not realised yet, the data is categorised as 'F-Plan'. Other facilities that do not fall in these categories are addressed as ' F-Other'
City Amenities	Overview of the size of the available amenities that potentially improve the quality of living in the city, enhancing its international attractiveness as a place to live and work. This field distinguishes four functional categories related to the built environment: (A1) Cultural amenities: theatres and stages, music and concert halls, libraries, museums, art galleries, etc., (A2) Leisure amenities: Shopping centres and malls, retails districts, markets; restaurants, bars and pubs, etc.; (A3) Green & Sport amenities: parks, beaches, lakes, natural reserves, forests, sport halls, and centres.

Table 3.8 Overview and description of data classified as 'Functional'

PHYSICAL DATA This refers to the physical aspects of the campuses and their surroundings that might help to describe the spatial qualities of technology campuses. It distinguishes several fields outlining different scales, sizes and location characteristics of the objects in relation to relevant structures of their hosting cities according to knowledge-based urban development.	
Campus scale	A distinction on the scale of the campus in relation to its urban context in three categories according to their perceived physical boundary: (S) Small - Portfolio in an Area: the campus is perceived as a group of buildings in a defined area (M) Medium - Area in a District: the campus is perceived as an area that is part of the city (L) Large - District or Town: the campus is perceived as a large part of the city and in some cases, as the city itself.
Land use area	Numeric data in hectares of the area occupied by the objects.
City density	Contextual information to place the size of the campus in relation to the size of the city in number of inhabitants per square kilometre
Transportation city	Contextual information to positioning the campus in relation to the spatial structure of its hosting city. For instance, outlining the main transportation systems in the city provides with an overview of the possible ways to access the object in term of transportation.
Distance	Data exploring the concept of proximity in knowledge based development. For instance, the data collected situate the accessibility of the campus in relation to three important elements of the urban structure for knowledge-based development: (1) Campus's distance from University Campus: Considering the university campus, as a relevant concentration of talent (knowledge workers and students) that accommodates the knowledge base of the city (2) Campus's distance from Core City Centre: This core is mainly associated with the concentration of attractive places for talent. In this research this core centre has been positioned where the functional centre of the city is –e.g. downtown or Central Business Districts- and/or where the main accessible points are –e.g. central train stations (3) Campus's distance from Airport: this place is associated with the access point for international talent to the campus, considering the relevance of mobility patterns in KBD. Accordingly, the campus's distance from these three places is measured in both space and time by using Google Maps as main resource for data collection. For instance, searching directions from the coordinates points where the campuses are located to the destinations described above*.
* The spatial distance is measure in kilometres and in minutes. Both are calculated according to the transportation means (by car, by public transport, walking) used in the analysis. In most of the cases, public transportation is preferred measuring the distance, since it might cover a larger group including young international talent and/or students who commute by other means rather than car. Nevertheless, Google data on public transport is limited to their coverage area, containing data on participating public transit agencies. In cases where this data is not available, car is used to measure the distance.	

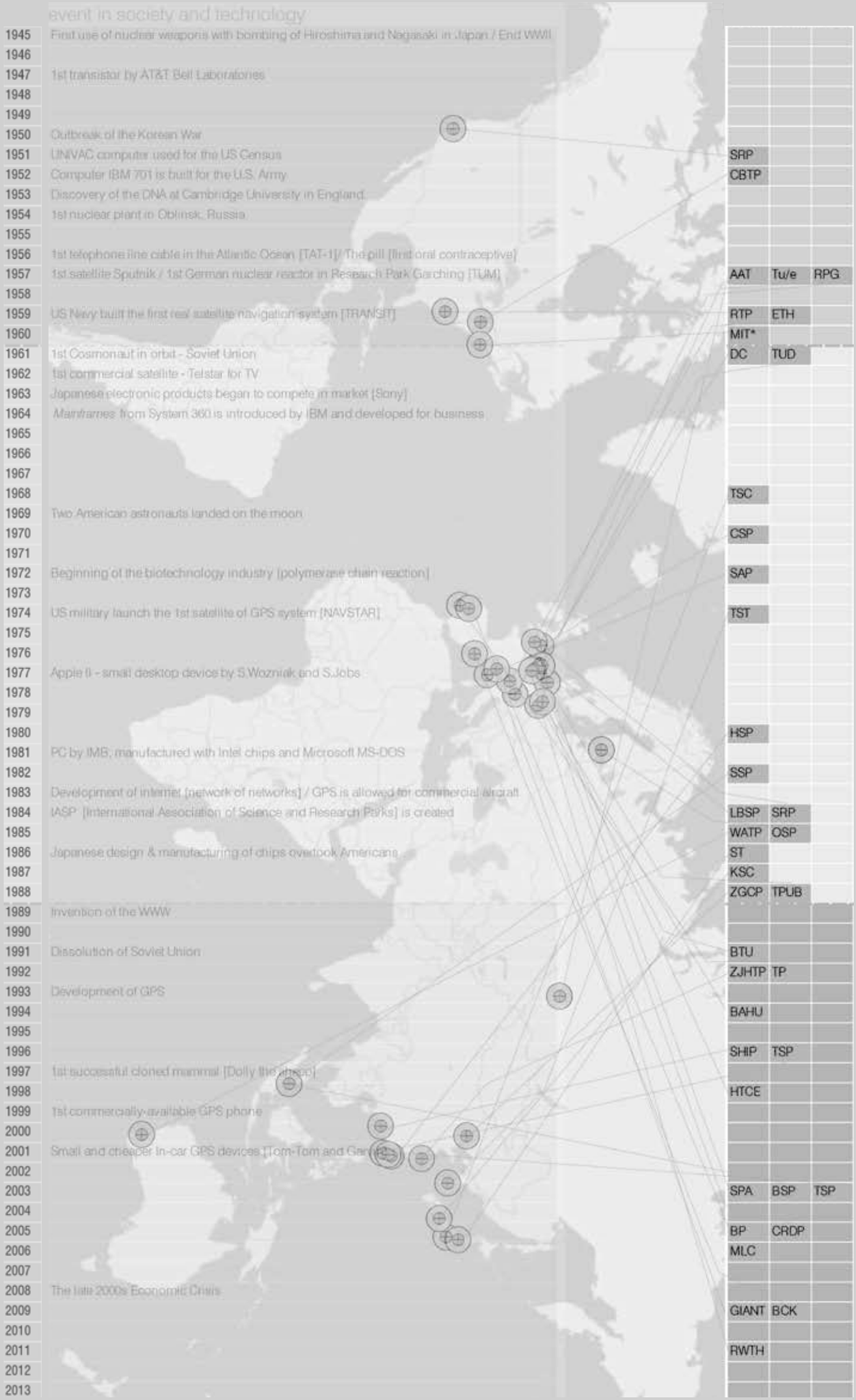
Table 3.9 Overview and description of data classified as 'Physical'

palo alto, usa
munich,de
eindhoven,nl
ithaca, usa
novosibirsk, ru
the triangle, usa
zurich, ch
enschede,nl
delft, nl
cambridge, uk
daejeon, kr
guildford, uk
cote d'azur, fr
singapore, sg
tsukuba, jp
cambridge/boston, usa
leiden, nl
perth, au
espoo/helsinki, fi
hsinchu, tw
kansai/kyoto, jp
cottbus, de
bremen, de
beijing, cn
barcelona, es
sittard-Geleen, nl
sendai, jp
shanghai, cn
berlin, de
lisbon, pt
amsterdam, nl
shenzhen, cn
tainan, tw
grenoble, fr
taichung, tw
coimbra, pt
EXPO'85
aachen, de

B. Description

What are the evident characteristics of technology campuses from the built environment perspective?

Describing the demand for- and the supply of technology campuses provided evidence that documents them from a built environment's perspective. This descriptive study illustrates that technology campuses are planned built environments envisioned and developed by universities, firms, and/or governments to stimulate innovation and encourage socio-economic development. Besides, their form and function are the result of explicit goals and intentions. In some cases, their spatial configurations have been influenced by modern and contemporary urban planning concepts but not all of them can be attributed to planning principles. Thus, the explicit intentions that shaped the built environment of technology campuses cannot be generalised.


event in society and technology
1945 First use of nuclear weapons with bombing of Hiroshima and Nagasaki in Japan / End WWII
1946
1947 1st transistor by AT&T Bell Laboratories
1948
1949
1950 Outbreak of the Korean War
1951 UNIVAC computer used for the US Census
1952 Computer IBM 701 is built for the U.S. Army
1953 Discovery of the DNA at Cambridge University in England
1954 1st nuclear plant in Oblinsk, Russia
1955
1956 1st telephone line cable in the Atlantic Ocean [TAT-1]/ The pill [first oral contraceptive]
1957 1st satellite Sputnik / 1st German nuclear reactor in Research Park Garching [TUM]
1958
1959 US Navy built the first real satellite navigation system [TRANSIT]
1960
1961 1st Cosmonaut in orbit - Soviet Union
1962 1st commercial satellite - Telstar for TV
1963 Japanese electronic products began to compete in market [Sony]
1964 Mainframes from System 360 is introduced by IBM and developed for business
1965
1966
1967
1968
1969 Two American astronauts landed on the moon
1970
1971
1972 Beginning of the biotechnology industry [polymerase chain reaction]
1973
1974 US military launch the 1st satellite of GPS system [NAVSTAR]
1975
1976
1977 Apple II - small desktop device by S.Wozniak and S.Jobs
1978
1979
1980
1981 PC by IMB, manufactured with Intel chips and Microsoft MS-DOS
1982
1983 Development of internet [network of networks] / GPS is allowed for commercial aircraft
1984 IASP [International Association of Science and Research Parks] is created
1985
1986 Japanese design & manufacturing of chips overtook Americans
1987
1988
1989 Invention of the WWW
1990
1991 Dissolution of Soviet Union
1992
1993 Development of GPS
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1997 1st successful cloned mammal [Dolly the sheep]
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1999 1st commercially-available GPS phone
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2001 Small and cheaper in-car GPS devices [Tom-Tom and Garmin]
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2008 The late 2000s Economic Crisis
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CBTP
AAT Tu/e RPG
RTP ETH
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DC TUD
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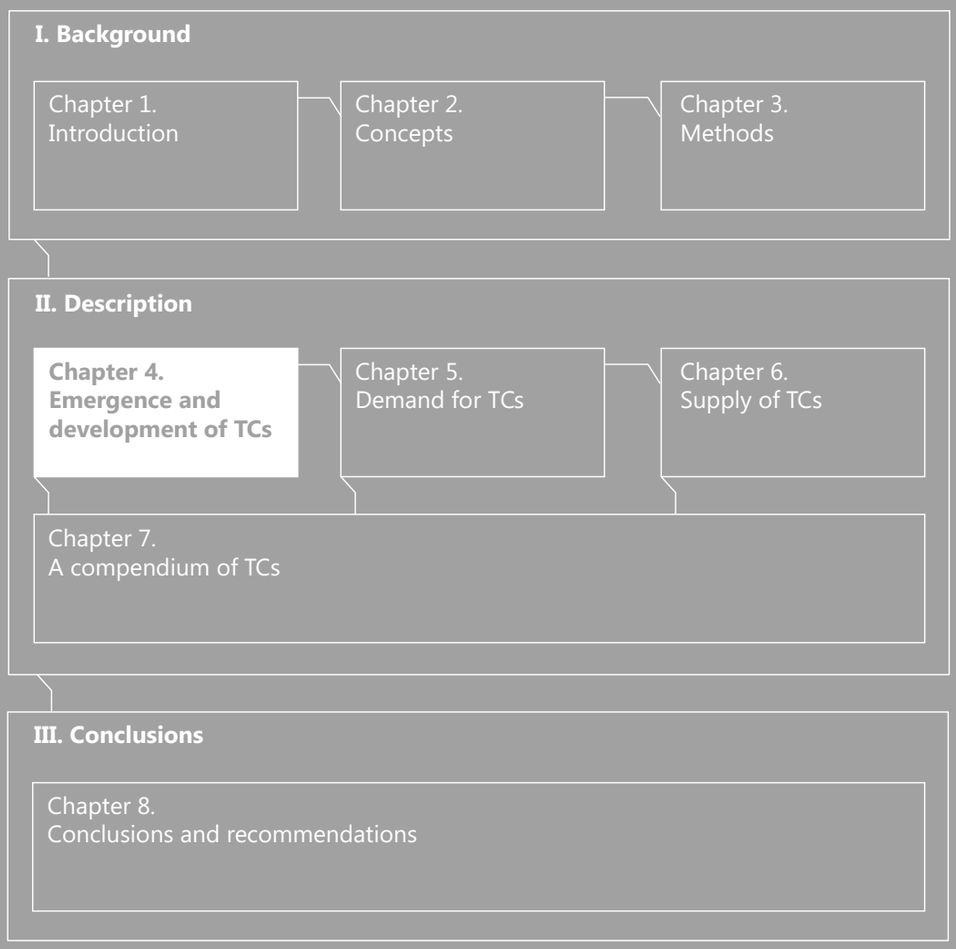
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4. Emergence and development of technology campuses

The practice of developing technology campuses emerged and evolved in different periods of technology development, in which 'research' became essential for the creation and application of knowledge. These periods are recognised as the atomic age (1945-1960); the space age and the ICT industrial revolution (1961-1988), and the digital and information revolution (1989 – present).

Initially, the demand to accommodate different research activities leading to technology transfer was supplied in existing university campuses or in newly built environments that resembled the setting of university campuses.

Undeniably, important technological developments in the 20th century originated from research advancing medical, space and defence projects, which accelerated the innovation process and the prosperity in industrialized countries. For instance, innovations such as the transistor (1947), the radar (1941-45), the computer (1943-46), the discovery of the DNA (1953), the satellite (1957), and the World Wide Web (1989), among others are good examples of the research outcomes in such periods. Since the late 1990s, the importance given to tech-based research in stimulating innovation has increased in the knowledge-based economy with the development of policies at regional and national levels. As a result, investing in research and its required infrastructure has become critical for society because this activity is essential for the creation and application of new knowledge leading to innovation.

Along with significant technological developments, this chapter identifies trends in campus developments by outlining changes in the built environment accommodating tech-driven activities. Initially, the demand to accommodate different research activities leading to technology transfer was supplied in existing university campuses or in newly built environments that resembled the setting of university campuses[10]. The first (known) of this kind is Stanford Industrial Park, today named Stanford Research Park, which is the cornerstone of what would eventually be known as Silicon Valley. Eventually, this supply became a model that has been used in different regions of the world until today. This practice has given to concentration a leading role in the accommodation of research activities. The context in which the variety of technology campuses emerged and developed is described in three periods as follows.

4.1. The post-war period & the atomic age.

The origin of the R&D Park and Nuclear power in technology campuses

The historical events of the early 1940s marked an important moment for global technological developments in the 20th century. Indeed, several important technological developments trace their origin to World War II, when the complexity of modern weapons and the urgency of war inspired engineers and mathematicians in several countries to accelerate the process. Examples of these are the creation of the first transistor at AT&T Bell Laboratories in 1947 used in radio, television or other electronic device; and the first time a computer, UNIVAC, was used by the United States Census in 1951 and not for military purposes (Headrick, 2009). By the same year, Stanford Industrial Park, as it was called in that moment, start its construction. On April 7, 1953 the IBM 701, built in 1952 for the U.S. Air Force after the outbreak of the Korean War, was formally unveiled to the public as the IBM 701 Electronic Data Processing Machines (Ibm-Corporation, 1994, 2013b). 'For a decade after WWII, first-generation computers were so complex and costly that only the United States government could afford to operate them for military purposes' (Headrick, 2009 p.132). The IBM 701 was the first IBM large-scale electronic computer manufactured in quantity and the IBM's first commercially available scientific computer. It was in this period when government spending on scientific research and development gained importance in the United States, both for military and medical purpose and mostly devoted to advance defence projects. For example, in 1943 at MIT the Radiation Laboratory in Building 20 was built as one of several facilities for government radar research. Then, in 1946 The Research Laboratory of Electronics is established in this building as the peacetime sequel (MIT, 2013). These initiatives and military motives behind marked a period regarded also as the Atomic Age.

The acknowledgment of an 'Atomic Age' began with the operation of the first nuclear plant located in Oblinks, Russia at the early historical moment known as 'The Cold War'. The technological developments then focused on atomic energy mostly derived from 'a race between the United States and the Soviet Union to develop nuclear bombs and missiles to deliver them anywhere within minutes' (Headrick, 2009 p.133). Despite the smaller economy of the Soviet Union compared with that of the United States, the Soviet government spent as much as the United States on nuclear weapons. In 1952 the United Kingdom engaged in the same nuclear race, followed by France in 1960 (Headrick, 2009). In the meantime, scientists and engineers found a less disappointing use for nuclear power: generating electricity. Besides the Russian case, more plants began operating in 1956 at Calder Hall, UK and in 1957 at Shippingport, Pennsylvania and the same year the first nuclear reactor in Germany was built at the Research Campus Garching of the Technical University of Munich (Hoeger & Christiaanse, 2007). Nevertheless, the use of nuclear power as a source of energy frightened society after several cases of leaks or explosions in nuclear plants occasioning among others human death, exposure to dangerous levels of radioactivity for people and ecosystems, and the displacement of communities living in their surrounding areas. Considering the costs of the disasters not only for society but also for the environment and for the economy, some countries closed their nuclear plants proving nuclear power as one of the biggest technological failures in the world's history.

Technological development was, more than ever, a sign of nation's power. Competitiveness was driven by different motives. Besides the nuclear power attention, important developments are outlined in this period. In 1956, the first telephone line cable was laid in the Atlantic Ocean (TAT-1), which was an important advance in long-distant communications once fibre-optic cables came to optimize the capacity of telephone line systems. In 1957, the Soviet scientist launched the first satellite named Sputnik into orbit around the world. This development surprised the world specially the American military research that was busy developing bombs while Soviets were secretly working on rockets that could reach any place on earth carrying a hydrogen bomb (Headrick, 2009). In 1959 the U.S. Navy built the first real satellite navigation system, which was called TRANSIT. The system was designed to locate submarines, and started out with six satellites and eventually grew to ten (Sullivan, 2012).

[10] Large research facilities were developed in the existing premises of universities of technology such as the Radiation Laboratory built in 1943 at MIT campus in Cambridge as one of several facilities for government radar research (MIT history line, accessed in 2013). New campuses resembled the spatial configuration of the traditional college campus, in which the self-standing buildings on the green were arranged in a functional setting that looked inwards.

Parallel, the first advance in biomedical technology after the Penicillin, introduced in WWII, was the discovery of the DNA in 1953 at Cambridge University in England, explaining in codes how an organism was formed and how it reproduced (Headrick, 2009). Other experiments in this area, advanced the development of biotechnologies such as the oral contraceptive in 1956, which was put on the market in the early 1960s called 'the pill' as the most important pharmaceutical product in history (Headrick, 2009).

4.2. The space age & ICT industrial revolution.
The emergence of the Asian technology campuses

This period began with an event that changed the perceived 'war race' between the United States and the Soviet Union: the first cosmonaut, Yuri Gagarin, is put into orbit by the Soviets and ten months later, an American team launched their cosmonaut, John Glenn, into orbit too (Headrick, 2009). By the end of the same decade, two American astronauts landed on the moon in 1969. Extraordinary accomplishments in human science and technology by these two countries can be attributed to the disposal of money and talent. Soon, after Sputnik, several American and Soviet military satellites came into orbit, but it was until 1962 when Telstar, the first commercial communication satellite, began to transmit television broadcasts worldwide allowing the world to enter an era of instantaneous global telecommunications (Headrick, 2009). Back then, many satellites were and still been used in communications, meteorology, astronomy, map-making, and agricultural and geological surveying.

Despite the fact most of the technologies introduced until this moment were originated in North America or Europe, many of the items available –e.g. electronic equipment, cameras, appliances, motor vehicles- were produced in Japan. In the 60s the Japanese products began competing in the world market for consumer goods. For instance, the company Sony named before Totsuko, grew quickly when it began selling the first transistorized portable television. Indeed, by investing in R&D the company has remained strongly competitive on consumer electronics technology ever since (Headrick, 2009). Correspondingly, Tsukuba Science City, the first intervention of this kind in Japan, was built in 1968.

In 1964 Mainframes, a series of machines introduced by IBM as System/360 and developed for businesses, which according to IBM Corporation is the most important product announcement of the company history to date (IBM Corporation, 2011). In 1977, Joseph Wozniak and Steve Jobs, who assembled their first computer circuit boards in a garage, introduced Apple II -a small desktop device-. Apple II was aimed at the small-business market and by selling thousands of units, it became an instant hit (Headrick, 2009). The birth of the IBM Personal Computer or PC is dated in 1981. It was the first time that IBM contracted the production of its components to outside companies: Intel developed the processor chip and Microsoft developed the operating system, called DOS (Disk Operating System) (Ibm-Corporation, 1994, 2013a). Soon, by 1986 Japan entered the personal computer market overtaking the American firms in electronics manufacturing.

Parallel, a relevant advancement giving a different dimension to the computer and digital data was the 'Internet' or network of networks, developed in 1983 and allowing all kinds of computers to communicate with one another. By 1984, a million computers were connected through telephone lines (Headrick, 2009). Besides the computers, another electronic advance includes the development of GPS. In 1974 the branches of the US military, after having worked on a GPS system for the past eleven years, launched the first satellite of a proposed 24-satellite GPS system called NAVSTAR. Between the years 1978-1985 the military launches 11 more test satellites into space to test the NAVSTAR system, which by then was called simply 'the GPS System' but is only until 1983 that president Reagan offered to let all civilian commercial aircraft use the GPS system (once it was completed) to improve navigation and air safety (Sullivan, 2012).

It was in the post-war period when government spending on scientific research and development gained importance in the United States, both for military and medical purpose and mostly devoted to advance defence projects.

In the field of biomedical technologies, important advances took place in this period in which previous discoveries began to have practical applications. The development of laboratory equipment in 1972-73 that uses a process called polymerase chain reaction made possible to turn successful laboratory experiments into industrial products. This event marked the beginning of the biotechnology industry (Headrick, 2009). Overall, despite the government support for the development of defence devices the most important breakthroughs of the post-war years occurred in electronics and biotechnology, which open the door to the period we live in: the information age. An important issue is the change in the developments from government client oriented to customer and small business-oriented, leading to personalisation and access to technology.

Coincidentally, as soon as Japan entered the computer market, Sendai Technopolis (1986) and Kansai Science City (1987) were built as part of a large Japanese technology program. These two areas and Tsukuba Science City -mentioned before- are examples of areas regarded as Technopoles (Castells & Hall, 1994). Accordingly, 'Technopoles are generally planned developments. They contain significant institutions such as universities or research institutes, which are specifically implanted there in order to help in the generation of new information. Their function is to generate the basic materials of the informational economy' (Castells & Hall, 1994, p. 1).

An important event for the built environment in this context is that in 1984 the International Association of Science Parks (or IASP) is created. Two years later, in 1986, the Association of University Related Research Parks (AURRP), was formed in response to a growing interest in research and development activities based in such unique planned properties. The name was changed to the Association of University Research Parks (AURP) in 2001. Science Parks became an international phenomenon (Phan et al., 2005). Though, the definition of a research or science park differs widely. A well know definition of Science Parks (Link & Scott, 2003), includes three components: 'a real estate development; an organisational program of activities for technology transfer; and a partnership between academic institutions, government and the private sector'. As well, 'science parks include technology parks with a majority of tenants that are heavily engaged in applied research and development. Technology or innovation parks often house new start-up companies and incubator facilities' (Link & Scott, 2003). Next to it, there is de definition of a university research park, which is 'a cluster of technology- based organisations that locate on or near a university campus in order to benefit from the university's knowledge base and its on-going research. The university not only transfers knowledge but expects to develop knowledge more effectively given the association with the tenants in the research park' (Link & Scott, 2006).

Similarly, AURP defines a university research park as 'a property-based venture, that includes five components: master plans property designed for research and commercialization; it creates partnerships with universities and research institutions; it encourages the growth of new companies; it transfers technology; It drives technology-led economic development' (AURP). In 2013, there were almost 400 Science Parks registered with IASP (See Figure 4.1) and more than 700 research, science and tech parks are members of AURP (AURP).

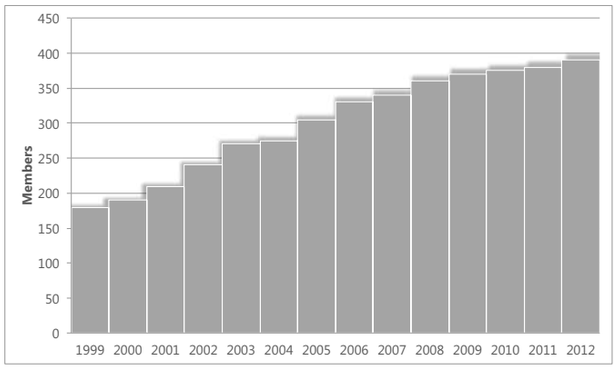


Fig.4.1 Number of Science Parks registered from 1999 until 2012 at IASP. (Carvalho, 2013)

4.3. The digital & information Age
Global coverage and hybrid developments

An important development opening the doors for the information revolution was in 1989 the creation of the 'World Wide Web' by Tim Berners-Lee of the European Nuclear Research Centre in Geneva, allowing computers to connect anywhere on Earth.

In this period, technology is not related to a history of global war. In fact, it is outlined the end of the Cold war with the dissolution of the Soviet Union in 1991. On the contrary, the use of technology in other conflicts allowed military strikes to minimise the civilians' casualties. First, it is the use of precision guide munitions in Gulf War (1990-1991) and the use of military Global Positioning Systems, which was crucial to navigate through the desert. And second, it is the development of high-tech tools technologies by the Defense Advanced Research Projects Agency for the U.S. military.

In 1999, the mobile phone manufacturer Benefon launched the first commercially available GPS phone, a safety phone called the Benefon Esc! The GPS phone was sold mainly in Europe, but many other GPS-enabled mobile phones would follow.(Sullivan, 2012). In 2001, as GPS receiver technology got much smaller and cheaper, private companies began pumping out personal GPS products, like the in-car navigation devices from Tom Tom and Garvin.

In the fields of Biotechnology and Medical Sciences it is outlined an important event: in 1997, the first successful case of a cloned mammal, a sheep called Dolly, was born. Cloning became an important an controversial advance because the technology capable to clone a human being exist but has not been used yet for many reasons apart from technological determinism.

Along with technological advancements, several technology campuses have been built all over the world. A preliminary global scan of these areas has shown that the physical interventions are diverse in terms of design concepts, scale of developments, location characteristics, and denominations. Moreover, it has been observed a pattern of change in the focus of the research activity they accommodate. This could be associated to the conditions of the historic periods outlined here. For instance, the variety of campuses has shifted from industries relevant during the ICT industrial revolution towards emergent ones resulted

As soon as Japan entered the computer market, Sendai Technopolis (1986) and Kansai Science City (1987) were built as part of a large Japanese technology program.

from the knowledge-based economy (e.g. Biotechnology and Digital media). In some cases, the physical interventions initiated to accommodate specific industries have adapted the shift in the economic conditions brought by the knowledge-based economy[11]. The proximity of companies to universities and/or higher education institutions could be one crucial response adapting this shift, given the relevance of tertiary education in productivity growth highlighted in global developmental reports (OECD, 2011). Correspondingly, the focus of regional policies on education, innovation, cities and regions are central issues where universities have emerged not only as engines to attract knowledge workers and to create knowledge, but also as engines of urban transformations (McCann, 2012).

In this context, the term campus is increasingly addressed in contemporary research and in different regions. There are different definitions for the word campus, evolving since its origin in the late 18th century from Latin campus 'field' (Oxford-Dictionaries) which was primarily associated to the grounds and buildings of a university or college. Recent research on the management of the university campus (Den Heijer, 2011) outlines a definition that distinguished the spatial, functional and managerial perspectives of these terms. The author refers to the university campus as 'location(s) of the university of the collection of the university and university-related buildings that are either used or owned (or both) by the university and have a role in achieving the institutional goals'.

Conversely, other definitions of campuses involve several institutions besides universities. For instance, an inventory research -commissioned by the Dutch Ministry of Economic Affairs, Agriculture and Innovation- on Dutch campuses, science parks and similar initiatives (BCI, 2012), identified two type of campuses in the Netherlands. The first type are Science & research parks, defined as 'Park-like' industrial estates, where R&D is carried out by universities, hospitals, research institutes and companies. The second type is Open Innovation campus, defined as 'former' business campus where a 'anchor tenant' carry out R&D, in which other companies can establish themselves and interrelation and research collaboration is actively encouraged[12]. Based on this approach, a definition on campus meets four criteria: 'First, a campus focuses on research and development. Second, a campus has a high quality environment with research facilities where multiple companies can use. A third important criterion is the presence of a manifest knowledge carrier, such as a university, college or a large research department' (Buck, 2012). One can say, this definition of campus is similar to the one described for Science parks.

Moreover, international research on the urban design of the campus (Hoeger & Christiaanse, 2007) refers to it in relation to the city. In fact, several denominations for campuses are addressed involving other stakeholders: Greenfield campus, High-Tech campus, Corporate campus, and the New Urban campus. Despite the absence of an overall definition of campus, this research outlines the contemporary relevance of these objects for urban planning and the diversity of their urban developments.

[11] Stanford Industrial Park, nowadays so-called Stanford Research Park at the heart of Silicon Valley, is a good example of adapting this economic shift towards knowledge and innovations as main drivers.
[12] Open Innovation is a business model that has been promoted in practice for cluster development (Chesbrough, 2003). Accordingly, 'Open Innovation is a paradigm that assumes that firms can and should use the external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology'.

The variety of campuses has shifted from industries relevant during the ICT industrial revolution towards emergent ones resulted from the knowledge-based economy (e.g. Biotechnology and Digital media)

In the urban context, a contemporary view of similar areas is the one addressed as knowledge locations (Carvalho, 2013). Accordingly, 'knowledge locations are planned-based initiatives aimed at agglomerating knowledge-intensive activities in a designated area or district. The concept of knowledge location encompasses a number of manifestations such as science parks and quarters, technology hubs, knowledge campuses or creative factories and districts, with a deliberate element of planning and policy aimed at promoting that agglomeration'. This definition is wider in scope and strengthens the relevance of the existing diversity of these areas, as well of the diversity of the different approaches studying them.

4.4. Chapter conclusions

When and where did technology campuses emerge and develop? Are there evident patterns in their emergence and development?

Technology campuses located across 16 industrialised countries in North America, Europe, and Asia-Pacific emerged and developed over the 20th century. Indeed, the empirical information collected from the survey ratifies that the development of technology campuses as a built environment phenomena is linked to three periods of technological development in industrialised countries: (1) the post-war period or atomic age, (2) the space age and ICT industrial revolution and (3) the digital and information age (See Figure 4.2).

Nowadays, most of these built environments accommodate multiple organisations that perform research activities in a broad range of technology fields to support different core businesses. The most common fields are biotechnology, information sciences, energy, materials and engineering (See Figure 4.3).

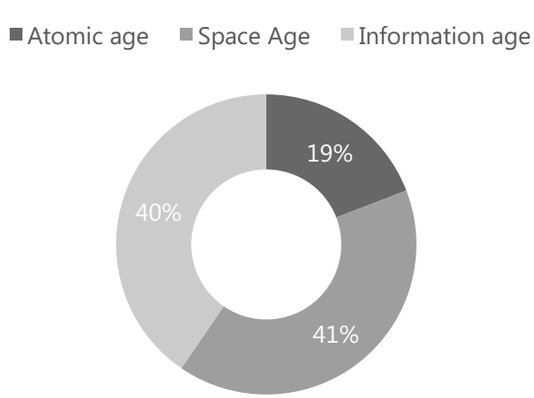
An overview of the cases documented in this research, outlining the places and periods of emergence (or significant development changes) are illustrated in Figure 4.4 on the next page. Accordingly, the number of technology campuses -developed and documented in this research- has increased over time. During the post-war period or atomic age (9% of the sample), a pattern is observed between the development of technology campuses and the attention placed to advancing technologies after the WWII in the U.S.A., Russia and Europe.

During the space age and ICT industrial revolution (41% of the sample), the emergence of the first technology campuses in Asia is linked to the entrance of Japan and South Korea in the computers and electronics market, and the support of national governments encouraging industrial development in these countries. Similarly, more developments emerged in Europe as part of wide-national strategies to encourage sciences and technology.

During the Digital and Information age (40% of the sample), the latter pattern of development increased both in Europe and Asia with the increasing attention of tech-based research in the knowledge economy. This intensification of campus developments is specially perceived in Europe.

Overall, understanding the emergence and development of technology campuses helped revising the definition of technology campuses. The following definition of technology campuses as seen in this study connects different fields such as architecture, urban design, real estate management, planning, economic geography and business:

'Technology campuses are built environments facilitating the concentration of organisations in designated areas. They have been planned to- or evolved at accommodating tech-based research activities leading to the advancement of technologies, which are believed to be a result from the expected interaction among the organisations performing such activities'.



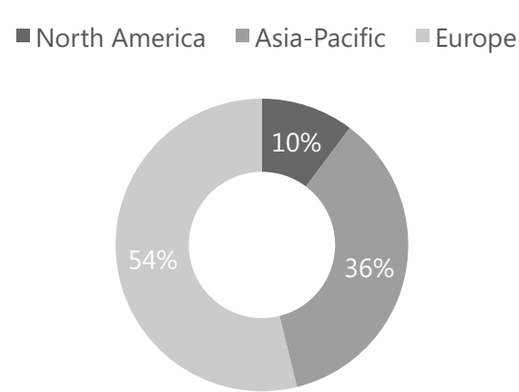


Fig.4.2 Distribution of the sample of technology campuses studied in this research according to the periods (left) and place (right) of emergence and development.

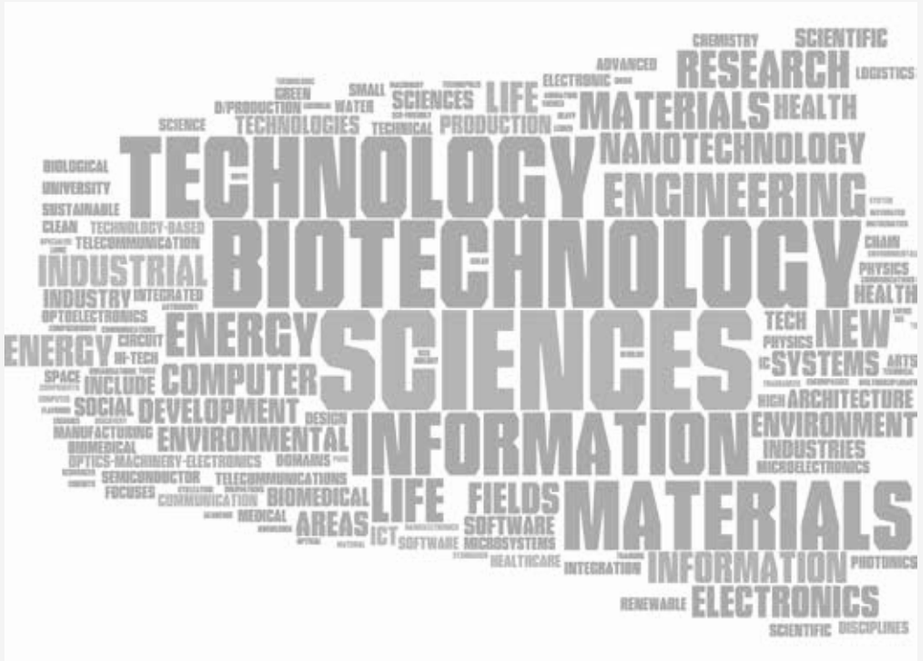


Fig.4.3 Cloud of words from the different technology fields characterising the research activities in the 39 campuses and their cities.

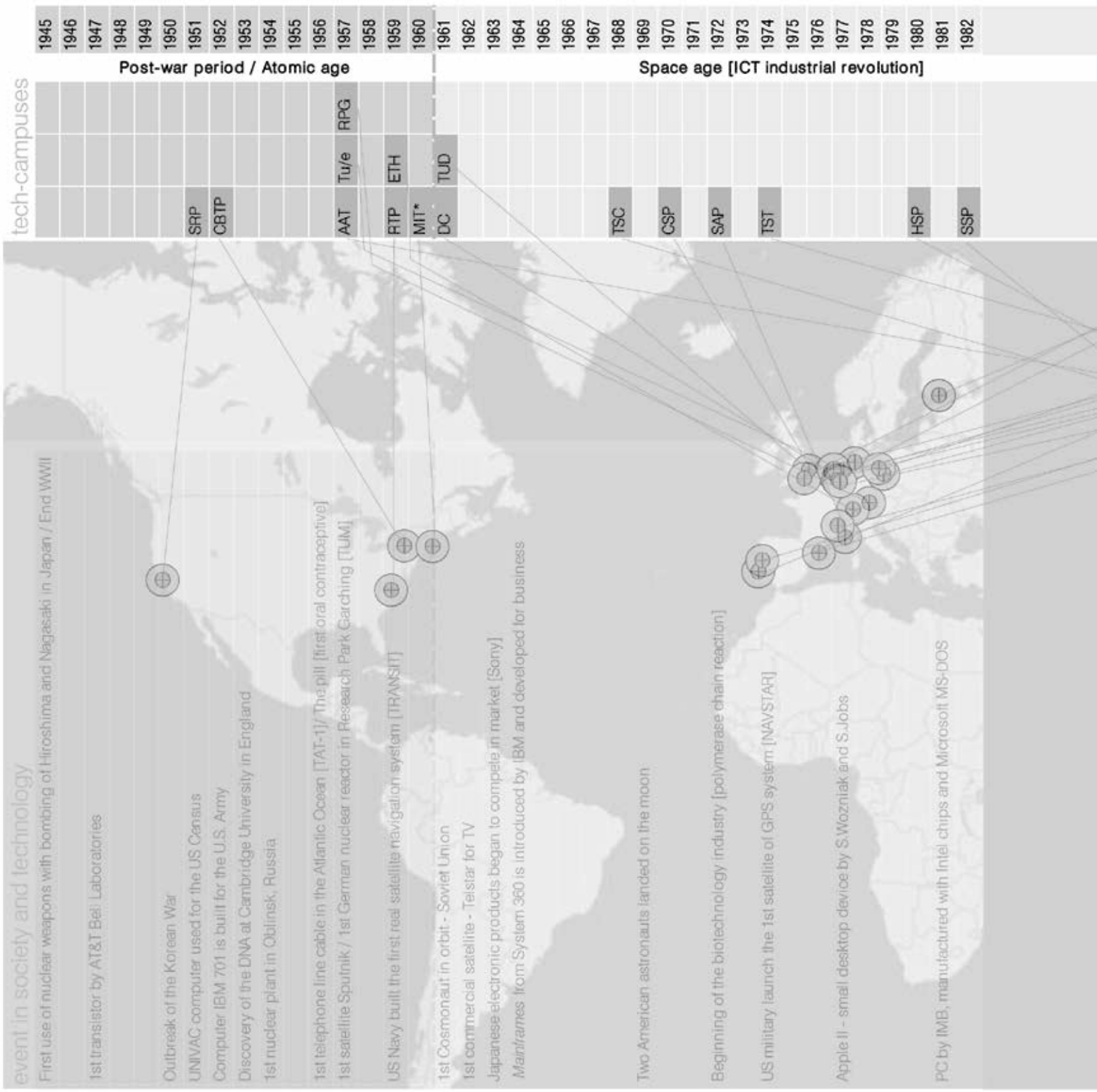
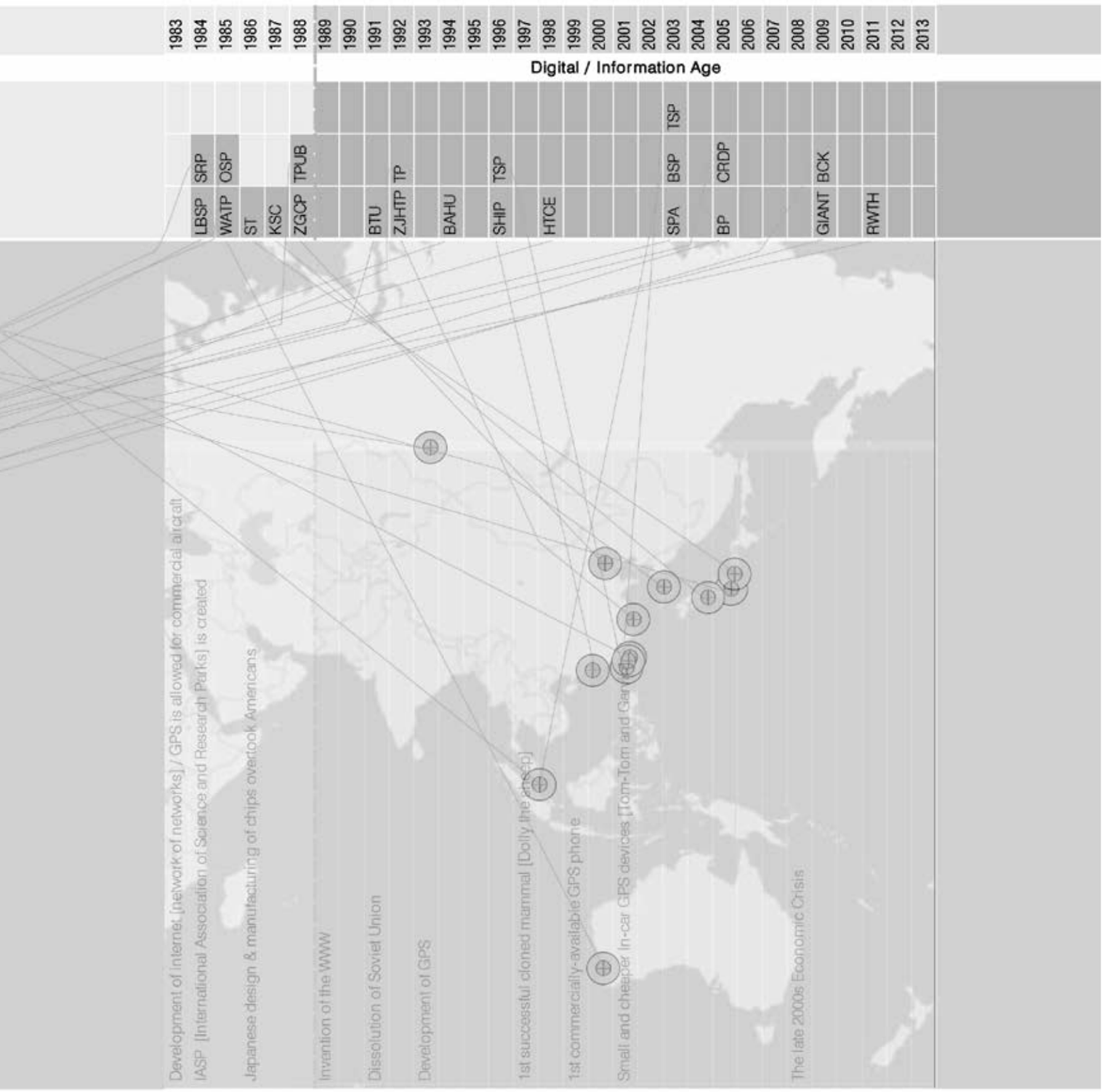


Fig.4.4 Times and places in which technology campuses emerged and evolved in relation to periods of technology advancements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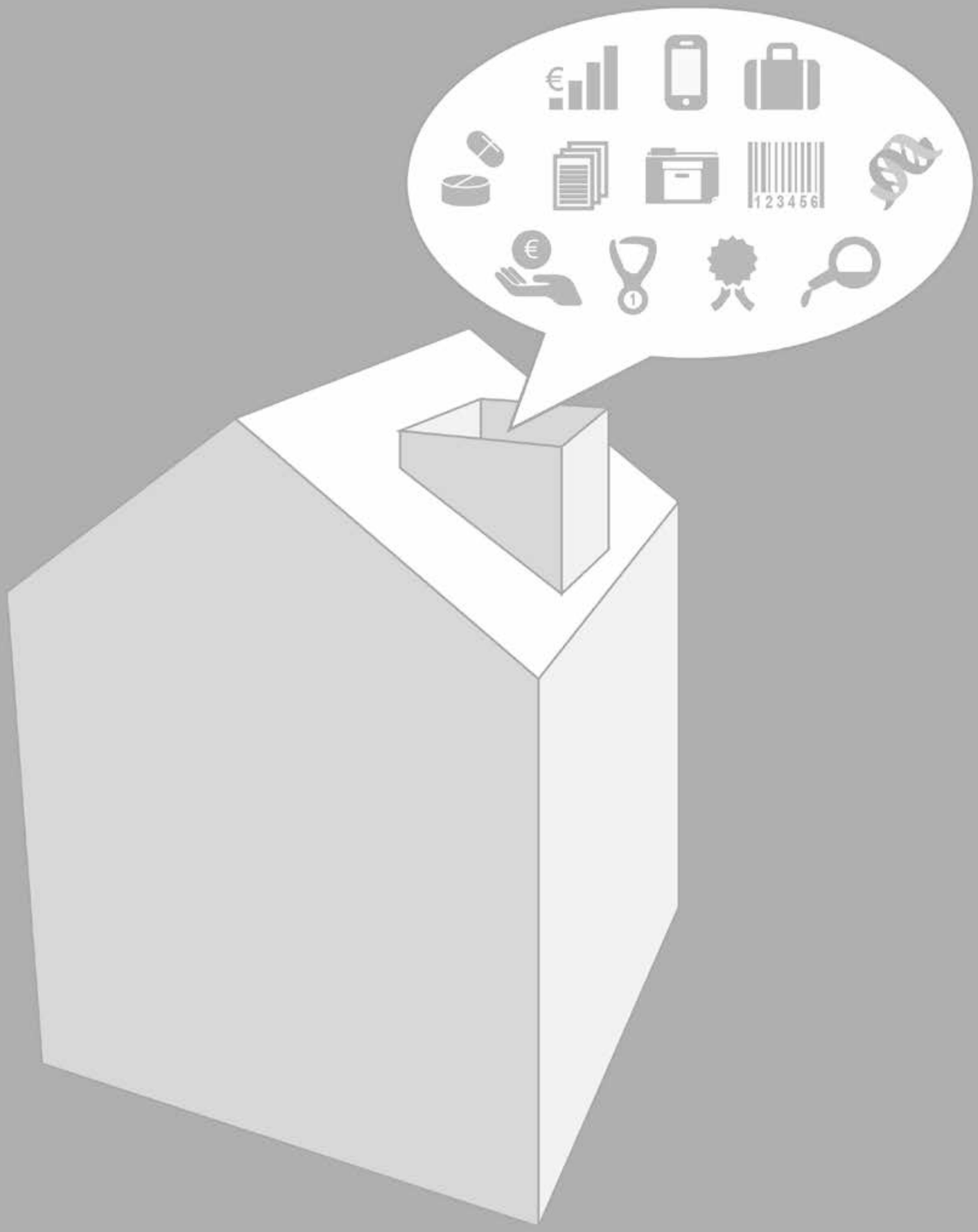
SPA
BSP
TSP
BP
CRDP
GIANT
BCK
RWTH
Development of internet [network of networks] / GPS is allowed for commercial aircraft
IASP [International Association of Science and Research Parks] is created
Japanese design & manufacturing of chips overtook Americans
Invention of the WWW
Dissolution of Soviet Union
Development of GPS
1st successful cloned mammal [Dolly the sheep]
1st commercially-available GPS phone
Small and cheaper In-car GPS devices [Tom-Tom and Garmin]
The late 2000s Economic Crisis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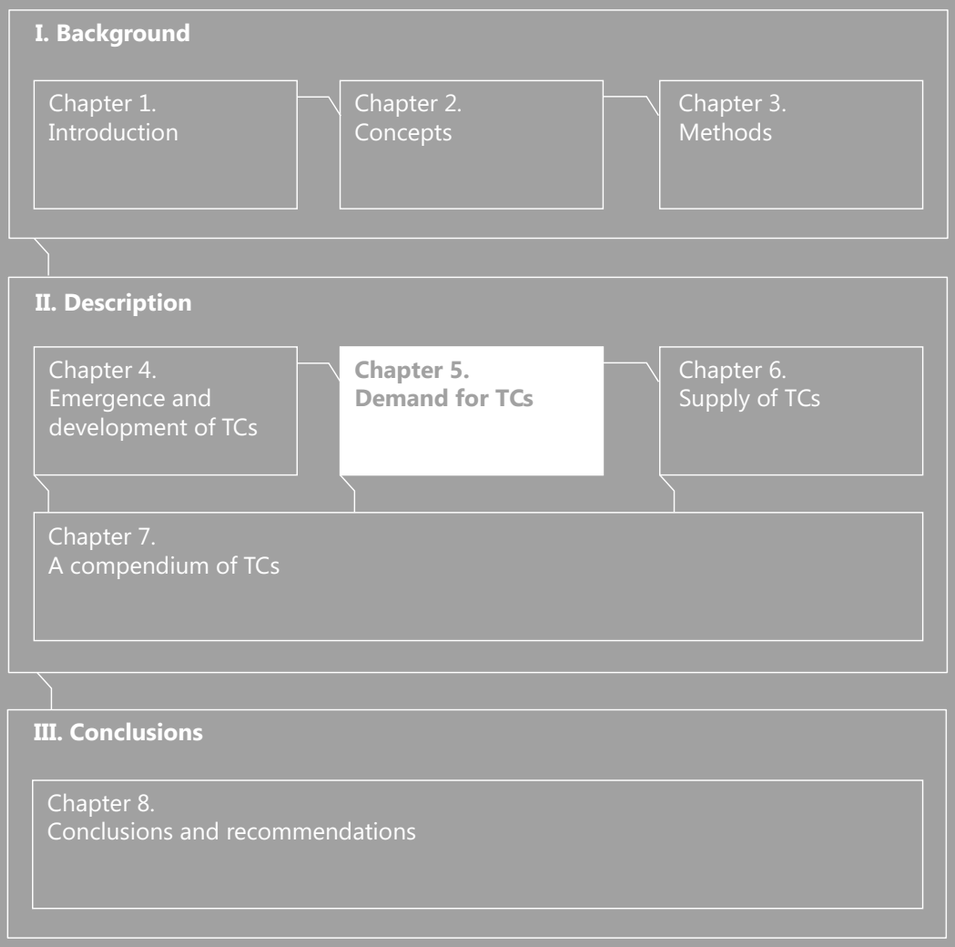
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5. Patterns in the demand for Technology campuses

The following paragraphs describe the general patterns in the demand for developing technology campuses by outlining the stakeholders and the goals involved in their strategic and financial structures. In doing so, this section aims to answer the questions: *Who are the stakeholders involved in the development of technology campuses? What are their goals?*

5.1. The Triple Helix as main stakeholder developing technology campuses

Three main types of organisations have developed technology campuses: universities; companies and governments. Unquestionably, these organisations correspond with the three spheres whose relationships form the so-called Triple Helix concept: university-industry-government (Etzkowitz, 2008). Within these three main parties, three main stakeholders' roles have been identified.

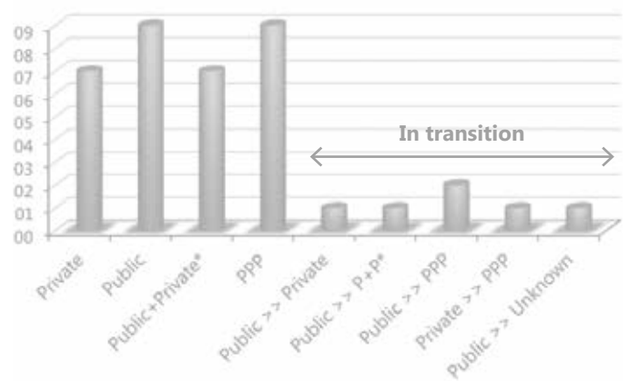
5.1.1. The founder

This stakeholder refers to the group of individuals or entity that established the campus. For instance, technology campuses have been founded by several entities: public and private universities; private companies; government-owned companies; governmental entities at national and municipal levels; and established Public Private Partnerships (PPP). Depending on the case, technology campuses have been founded either separately by one of these entities, or the cooperation between two or few of them when partnerships are not officially established. Therefore, three main types of funding sources are distinguished characterising the ownership structures of technology campuses: public-, private-, and mixed capital. Moreover, it is observed as a pattern that several campuses originally founded by one entity -with public or private capital- have recently established PPP. This outlines the relevance of cooperation when raising capital investments needed to (re) develop physical infrastructure for research such as campuses.

The data collected on actual capital investments in this survey was limited to very few cases and not suitable for comparison[13]. However, it is publicly known that universities, companies, and governments in developed economies have invested millions of Euros developing technology campuses[14]. Only in Europe, €86 billion has been allocated on research and innovation including 'Research Infrastructure'[15], Entrepreneurship, ICT development and human capital actions in the period 2007-2013 from EU structural funds (European Commission, 2015). This financial support to research infrastructures has been gaining importance in the context of European policy through EU framework programmes. Recently, Horizon 2020 supports research infrastructure with the allocation of about €2.5 billions between 2014 and 2020 (European Commission, 2015).

Three main types of organisations have developed technology campuses: universities; companies and governments.

Several campuses that were originally founded by one entity -with public or private capital- have recently established PPP. This outlines the relevance of cooperation between public and private parties when raising capital investments needed to (re) develop physical infrastructure for research such as campuses.



PPP: Public Private Partnership (officially established)
P+P*: Public-Private cooperation (not officially established)

5.1.2. The manager

This stakeholder refers to the group of individuals or entity steering the functioning of the campus in use. It distinguishes several advisory and management structures that embody the responsible planning and management of property resources. For instance, an observed pattern is that technology campuses are increasingly managed by designated management units, which tasks are concerned not only with the management of the property but also with the development of the research cluster. It is also observed that the same management units are sometimes involved in the marketing and promotion the object to attract and support companies, or institutions. Therefore, these management units have several management divisions. For instance, Real Estate Management units or departments manage several technology campuses. In most of the cases, these structures correspond to the campuses that are funded with private capital. Nevertheless, in some campuses the structures of these management units are not clearly defined in the data found. Specially, in management structures that recently involve external parties that took no part in the foundation of the campus.

Technology campuses are increasingly managed by designated management units, which tasks are concerned not only with the management of the property but also with the development of the research cluster including the marketing and promotion the campus.

[13] The documents analysed in this survey provided marginal financial data on the investments made in technology campuses. However, some institutional documents and journalism records address relevant figures sizing the financial investments in these built environments. For example, Royal Philips sold High Tech Campus Eindhoven for EUR€425 million in 2012. Similarly, Tibco Software sold Stanford Research Park for US$330 million in 2015.

[14] Recently, the development of new technology campuses has been announced in press releases. In 2013, Google announced the investment of US$120 million in its campus so-called Googleplex. In 2012, the development of New York Tech campus in collaboration between the city of New York and Cornell University was announced, which investments amounts US$2 billion.

[15] 'Research infrastructures refers to facilities, resources and related services used by the scientific community to conduct top-level research in their respective fields, ranging from social sciences to astronomy, genomics to nanotechnologies' (European Commission, 2015)

5.1.3. The promoter

This stakeholder is the group of individuals or entity stimulating -through activities such as marketing- the establishment and the development of campuses. Generally, external parties increasingly promote technology campuses. This pattern is predominant in campuses that are developed through public and private partnerships. Overall, this exploration identified two types of promoters. There are official promoters who are formally marketing the site. In some cases, they are involved in decision-making of the campus. For example, Asian cities/regions actively promote and market their technology campuses. In fact, some of them have been designated as especial development zones. As well, there are unofficial promoters who are the external stakeholders who informally market the object as a positive brand for the city.

Figure 5.1 illustrates an overview of main stakeholders defining and influencing the demand for developing technology campuses framed into the Triple Helix model (Etzkowitz, 2008). Indeed, this model helps to emphasize interactions between these spheres in specific roles when developing campuses. For instance, the identification of these cooperation levels suggests a sort of alignment in goals between these spheres. In fact, some similar goals and concepts are observed in several cases. These are discussed in the next section.

5.2. The strategic campus: goals on technology campuses and cities

The survey of technology campuses confirmed that the goals driving their developments and those of their current contexts are diverse, and sometimes multiple within one case. Although differentiation is outlined in the founding visions of technology campuses and their hosting cities, some similar goals and concepts are outlined in several of them. After a systemic review, eighteen different goals were initially identified on technology campuses and their hosting cities (or regions). Considering those that were predominant in the sample[16], a list of twelve main goals of technology campuses is being recognised an arranged according to their high proportion within the sample. A summary of the goals identified is described in Table 5.1.

Generally, external parties increasingly promote technology campuses. This pattern is predominant in campuses that are developed through public and private partnerships.

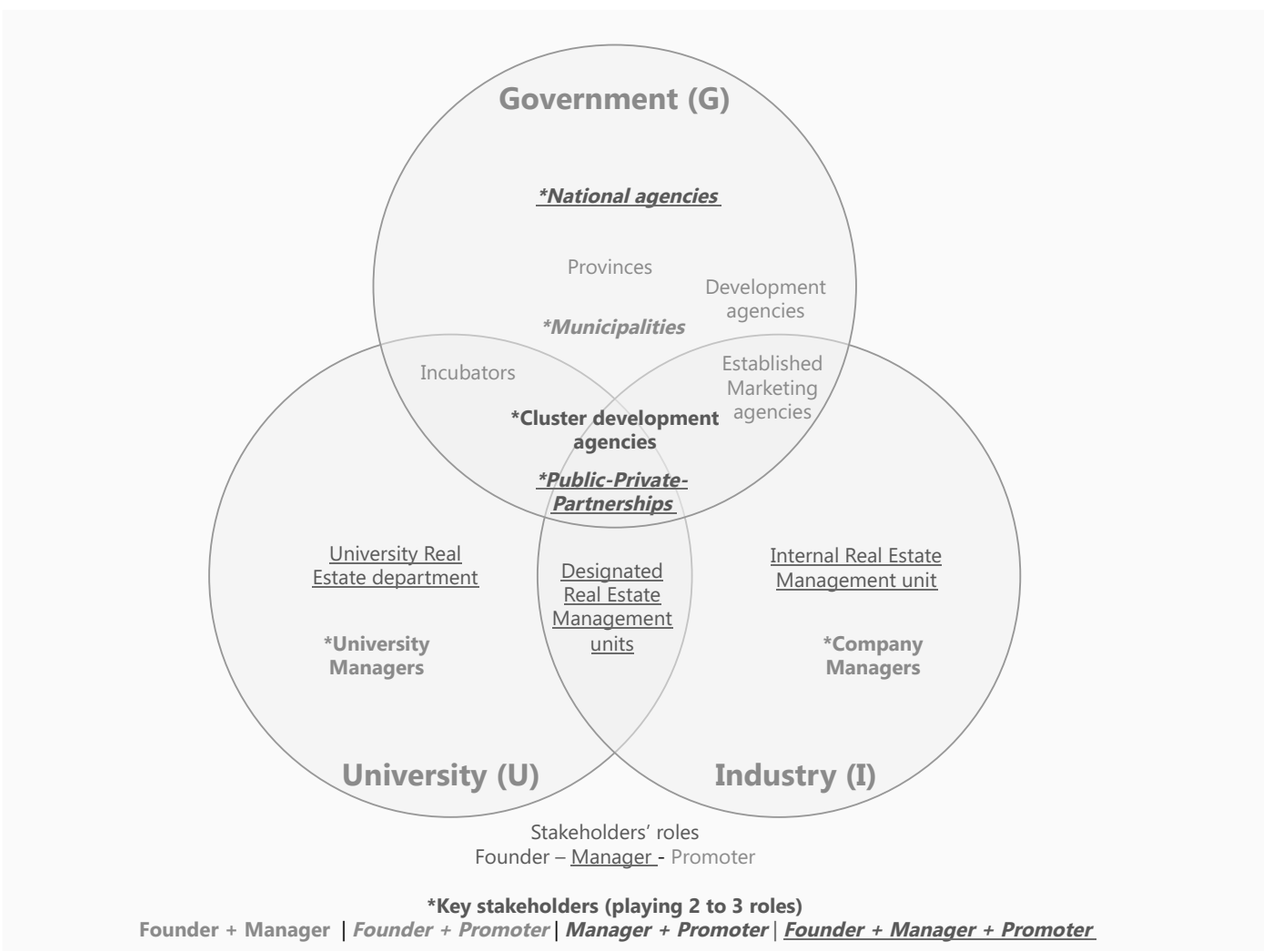


Fig.5.1 Overview of main stakeholders defining and influencing the demand for developing technology campuses framed into the Triple Helix model (Etzkowitz, 2008)

[16] Those goals were prevalent above the average of the total number of cases.

CODE	GOALS	# CAMPUSES	% SAMPLE
G1	Encouraging Innovation for economic growth and development	25	64%
G2	Attaining Economic growth and development (Employment, business activities and prosperity)	24	62%
G3	Encouraging Technology development for economic growth	22	56%
G4	Increasing attractiveness of place to live, to work, and to do business; and so, International competitiveness.	22	56%
G5	Encouraging Academia, Science and R&D for economic growth	21	54%
G6	Encouraging cooperation and collaboration among academia, industry and public parties (Supporting entrepreneurship and partnerships)	19	49%
G7	Increasing Economic resilience and sustainability (Promoting diversity of sectors and cluster development)	18	46%
G8	Supporting social infrastructure (community development; skills and learning capabilities development, human values and culture)	18	46%
G9	Enhancing creative culture, ideas growth and smart society development.	17	44%
G10	Supporting environmental sustainability and green development. (Improving urban quality and infrastructure development; encouraging renewal and relation of existing built environment)	17	44%
G11	Encouraging knowledge interaction, exchange, and networking. (Increasing chances for meeting and sharing; ecosystems of knowledge creation and exchange)	14	36%
G12	Strengthening competitive advantage in the knowledge economy (Strengthening knowledge sectors and positioning in the global knowledge economy)	12	31%

Table 5.1 List of main goals of technology campuses and their hosting cities within a sample of thirty nine cases.

Largely, the goals of technology campuses and their hosting cities are not only varied but also have a clear tendency at encouraging socio-economic development. Moreover, these goals are essentially reflecting those specific actions or initiatives carried out by cities or regions to succeed as knowledge-based cities/regions identified in literature and policy analysis (Chapter 2). Similarly, the words 'Innovation, Technology, Knowledge and Collaboration' –among others- are predominantly addressed as valuable for growth and development within such goals. In fact, the cloud of valuable words identified in the goals of technology campuses and cities are either the same or closely related to the aspects previously identified in literature as the enablers and the drivers leading the fundamental transformation of today's knowledge-based economy. It is not surprising to observe the tendency to encourage economic development in the goals of the cities. However, it is unexpected these goals are explicitly addressed by some organisations that have developed these areas, such us universities. Possibly, the increasing relevance of universities, industry and governments and their relationships in today's economy has influenced their roles and the direction of their goals, including their real estate goals.

Once again, the model of the triple helix helps to illustrate the cloud of words aligning the goals of each of these spheres, even though they keep their distinctive status (See Figure 5.2). In this figure, the cloud of words in the goals of technology campuses and their cities are clustered according to their correspondence in connotation. In addition, it outlines those that are the same as the aspects leading the fundamental transformation of today's and the knowledge-based economy identified in literature. Similarly, alignment in the goal of these spheres and its influence in real estate decisions can be emphasized by operationalising the list of goal according to the predominance of a goal in both campuses and cities. For instance, scores are given considering the campus's goal -as embedded within the organisational goals- more relevant for decision-making than the goals of the city as their context[17]. Thus, Table 5.2 operationalises the goals technology campuses, which are outlined by both campuses and cities in most of the cases.

Although differentiation is outlined in the founding visions of technology campuses and their hosting cities, some similar goals and concepts are outlined in several of them.

From an economic development perspective, it is observed that several cities have developed campuses as specific measures to attract business and promote themselves in an international context. For example, the designation of their administrative boundaries as special zones is one of these measures (e.g. Tsukuba as International Strategic Zone in Japan or Daedeok as Special Research and Development Zone). Some of these zones give advantage on regulatory standard requirements (e.g. tax incentives) and financial help from governmental body and local autonomy. An interesting pattern observed is that large campuses built as cities or outside cities are founded with public capital and increasingly with the establishment of PPP.

On the whole, the focus of this description on real estate goals as embedded within the organisational goals, confirms that the context of the knowledge economy and the aspects leading to today's economic shift, as described in literature and in policy, are essential to understand the contemporary general factors influencing decision making on these sites outside the organisational boundaries. For instance, Innovation, Knowledge, Resilience, Technology and Learning are addressed as major aspects influencing the context of decision-making in technology campuses.

Nevertheless, specific factors such as particular needs and/or available means influencing the supply of the campuses were not investigated at the scale of this description. Indeed, these particular aspects are related to the decision-making at certain times, which (re) define specific real estate goals within the organisational boundaries. Then, the reasoning of their existence cannot be generalised to all technology campuses. In fact, those reasons are inherent to each case and more in-depth information is needed to clarify the reasons of their existence.

[17] Scores are given in this order: City's goal (1 point); Campus's goal (2 points); Both City and Campus's goal (3 points)

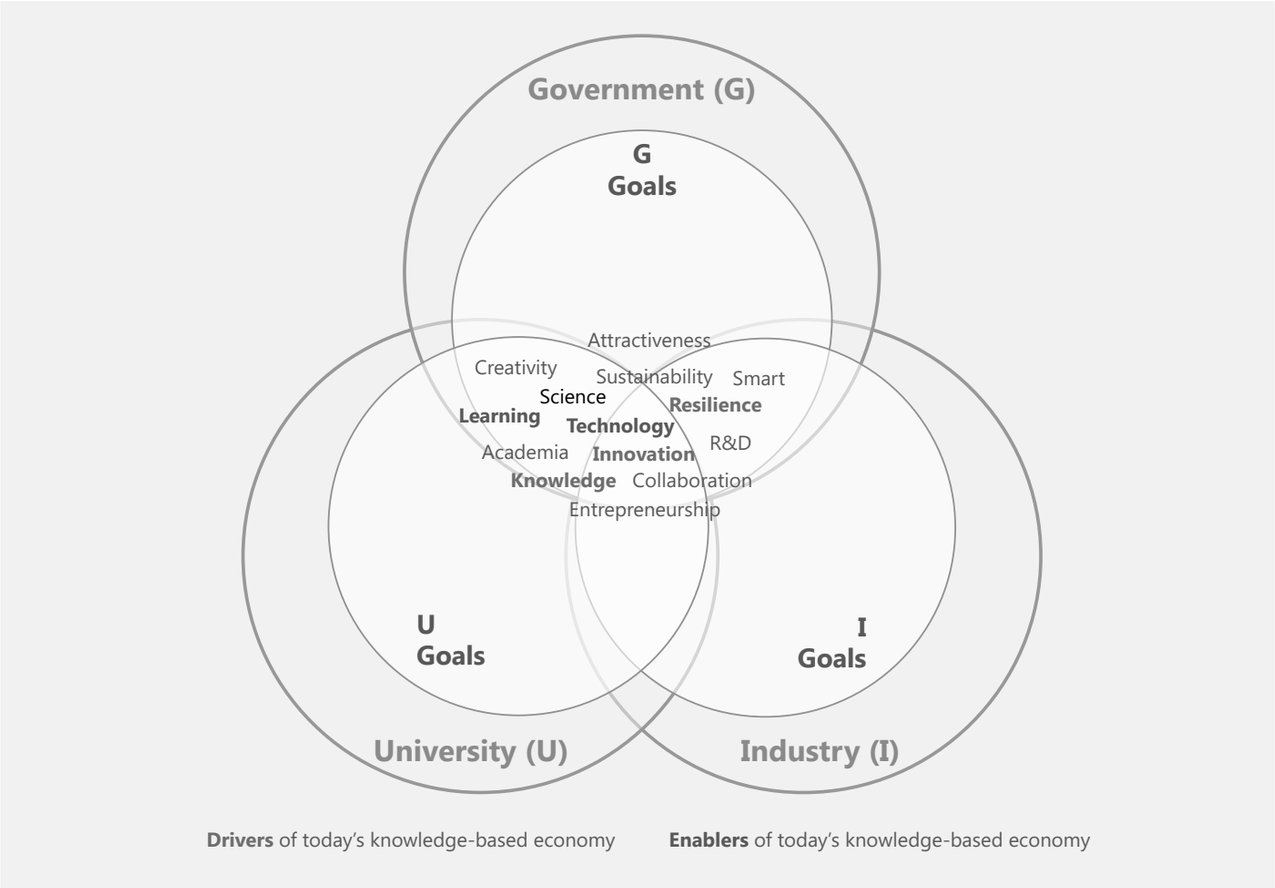


Fig.5.2 Cloud of words in the goals of technology campuses and their cities linked to the concept of the triple Helix and the aspects in literature leading the fundamental transformation of today's and the knowledge-based economy.

CODE	GOALS	SCORE
G5	Encouraging Academia, Science and R&D for economic growth	46
G1	Encouraging Innovation for economic growth and development	45
G2	Attaining Economic growth and development (Employment, business activities and prosperity)	44
G6	Encouraging cooperation and collaboration among academia, industry and public parties (Supporting entrepreneurship and partnerships)	37
G4	Increasing attractiveness of place to live, to work, and to do business; and so, International competitiveness.	36

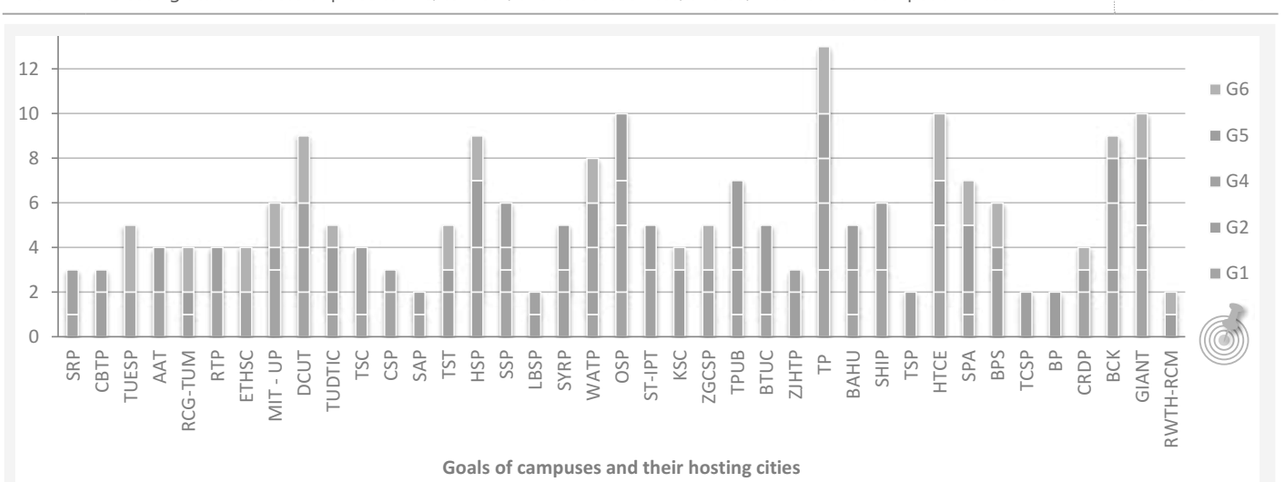


Table 5.1 Above: Overview of most common goals of technology campuses and their hosting cities. Below: distribution of most common goals within the sample of 39 campuses. The Y-Axis shows the points assigned to calculate the score - i.e. one point when it is a City's goal; two points when it is a Campus's goal; and three points when it is both a city and campus's goal.

5.3. Chapter conclusions

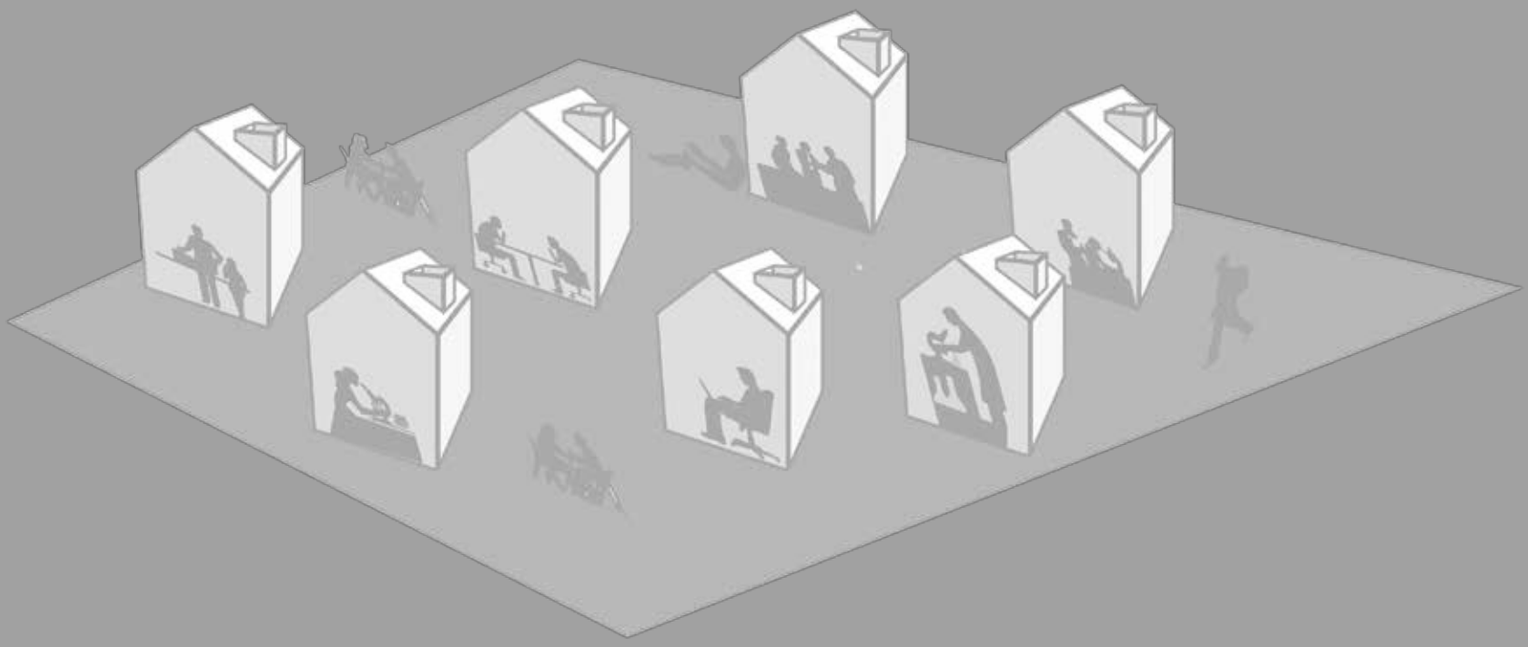
5.3.1. Who are the stakeholders involved in the development of technology campuses?

Technology campuses have been developed by three main types of organisations: universities; companies and governments. These types are recognised as the spheres of the so-called Triple Helix concept: university-industry-government. Within these three spheres three main stakeholders' roles have been identified, whose (inter) actions have made campuses possible: founders, managers and promoters. Thus, a large number of stakeholders and roles are identified. Some entities play more than one or two roles in the development of technology campuses over time and they are therefore identified as key stakeholders. Positioning the different bodies that were involved in the development of technology campuses in relation to the spheres of the Triple Helix shows how each of them are relatively independent and have distinct status. Conversely, positioning these roles in these three spheres may help to identify potential areas of cooperation to develop the technology campuses suggesting a degree of alignment in goals between these spheres.

5.3.2. What are these stakeholders' goals on campus?

The goals driving campus developments are diverse and multiple within one case (12 main different goals). For instance, while differentiation is outlined in some founding visions of technology campuses and their hosting cities, similar goals and concepts are identified in several of them with a clear tendency at encouraging social and economic development (See Figure 5.3) 'Encouraging innovation for economic growth and development' is the most popular goal among technology campuses (64% of the sample address this goal). 'Encouraging academia, science and R&D for economic growth' is the most popular goals addressed both in campuses and the cities (87% of the sample). The goals of technology campuses essentially reflect the actions or initiatives carried out by cities or regions to succeed as knowledge-based cities/regions identified in literature and policy documents. The tendency of universities and companies having similar goals addresses the possible influence of the economic relevance of the Triple Helix relationships on the overlapping roles of its constitutive organisations and so, the direction of their goals, including their real estate goals.

Fig.5.2 Cloud of words from the 12 main goals of technology campuses and their hosting cities illustrating the focus on knowledge-based development.



technopoles

creative factories

science parks

urban campuses

technology parks

science cities

knowledge locations

university campuses

greenfield campus

open innovation campuses

university research park

tech hubs

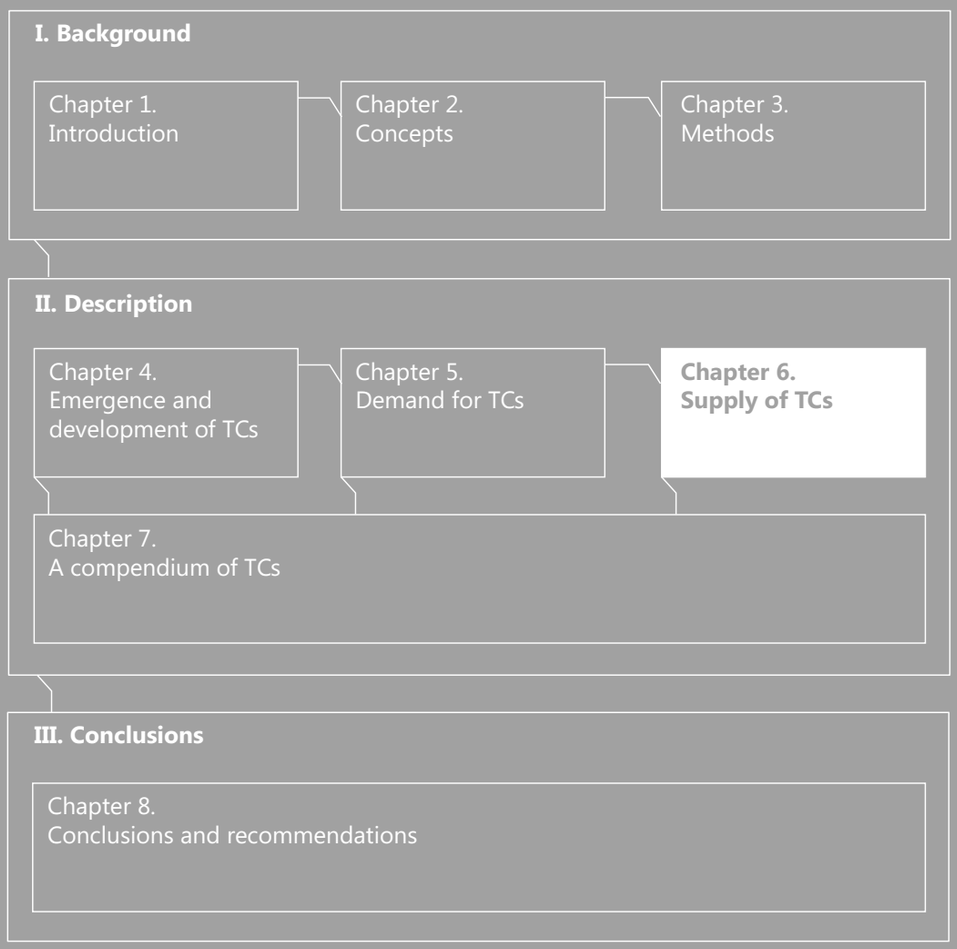
high tech campus

knowledge campuses

corporate campuses

quarters

technology campuses


I. Background
Chapter 1.
Introduction
Chapter 2.
Concepts
Chapter 3.
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II. Description
Chapter 4.
Emergence and
development of TCs
Chapter 5.
Demand for TCs
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Conclusions and recommendations

6. Patterns in the supply of technology campuses

The following paragraphs describe the general patterns in the supply of technology campuses by outlining their physical and functional characteristics (i.e. the supply of technology campuses refers to the product of man-made decisions with tangible characteristics defining its operational dimension). In doing so, this section aims to answer the questions: *Are there common patterns in the supply of technology campuses? What characteristics define the supply of technology campuses?*

6.1. The operational campus: the form and function of technology in cities/ regions

This study analyses the physical and functional data of technology campuses by using concepts from architecture, urban planning, urban design and real estate management theories already described in Chapter 2 (See section 2.3.2). Analysing the operational dimension of these built environments implies the description of the product that gives form and meaning to urban planning and design concepts. This analysis established links between five physic/functional characteristics and existing concepts from other fields, which were identified as relevant for this research through the review of the literature in the previous chapter (See Table 6.1).

This section describes as follows the common patterns identified, when analysing four of the five physical and functional characteristics of technology campuses: (1) location, (2) layout, (3) size and density, and (4) block pattern[18]. The following paragraphs outline the common patterns in each of these characteristics, followed by explanations.

6.1.1. Location patterns

Most technology campuses in this sample (1) are located in developed regions, (2) have a border condition, and (3) are near to- or in universities' locations.

According to the geographic position of the sample studied, it is observed that most technology campuses are located in developed regions of the world and few on BRIIC countries[19]. They are all industrialised countries (See Figure 6.1).

First, the analysis of the location characteristic describes the position of the technology campus in relation to the city or region as a whole. Therefore, topology has served to identify a set of relationships that the campuses and the cities can have with each other. Most of these relationships are related to specific developments of their temporal and social context. Through mapping, the following five topological relations were identified between the campuses and their hosting cities and summarised in Table 6.2.

As said, most of these relationships are dynamic and related to specific developments in their contexts. For instance, the most predominant relationship in the sample is City Touches the Campus. In most of the cases, campuses are located at the edge of the city. In some cases, they are in the city but the sites have a border condition e.g. separated by a waterfront, or a highway. For the first cases, it can be said these areas were built outside the city but due to distinct or combined urbanisation processes; they are already at the edge of the city. Such urbanisation processes could be related to the expansion of the city to their peripheries due to population growth, the settlement of other companies nearby these sites, or to the combination of both processes.

This border condition of technology campuses is observed globally with a representative number of campuses in this group in the total international sample. Technology campuses categorised as Touches may evolve to Contains or Overlaps depending in the particular dynamics in each context. For instance, this study found out that more than one relationship between campuses and cities could be already perceived in some campuses – i.e. campuses that are very large in size and partly dispersed, which parts have distinct characteristics[20]. This duality results from particular characteristics of the context in which campuses developed. Examples of all types of relationships are illustrated in Fig.6.2a to Fig.6.2e. These figures group the sample studied per each of these relationship to describe the distinct patterns observed also in each of the four data categories (strategic, financial, functional and physical).

	FORMAL/FUNCTIONAL CHARACTERISTICS	LINKS WITH THEORETICAL CONCEPTS OF INNOVATION
1	Location and settlement	Clusters, Competitive advantage, Proximity, Connectivity, Accessibility.
2	Spatial and functional layout	Proximity (geographic, social and cognitive); face-to-face interaction; creativity
3	Size and Density	Social interaction, Proximity, Diversity (of people, ideas, buildings and functions).
4	Block pattern	Creativity; Small blocks and Chances of encounter and interaction; Diversity; Walk-ability; Accessibility
5	Appearance	Attractiveness of place; Added value of real estate (e.g. supporting image and culture)
Source	Theories on the built environment (Architecture, Urban planning, Urban design, Real Estate Management)	Literature review on the role of the built environment in innovation (Urban economy, Urban planning, Real Estate Management)

Table 6.1 Overview of formal and functional characteristics of technology campuses in relation to relevant theoretical concepts linked to innovation.

[18] The sources documenting this qualitative survey were not suitable to collect data on the appearance of technology campuses. Therefore, this characteristic is not empirically documented.

[19] According to the OECD, the so-called BRIIC countries are the five largest developing and emerging economies, which accounted for more than one-half of non OECD global GDP in 2008. These are Brazil, China, India, Indonesia, and Russia.

[20] For example, TU Delft District and Technopolis and Innovation campus Delft distinguishes three main zones (i.e. north, centre and south). Each of them has particular features and their location characteristics in relation to the city are perceived differently. For instance, the north and centre parts are perceived as 'Overlaps' while the south is perceived as Touches.

Fig.6.1 Location of the 39 technology campuses surveyed in this study.

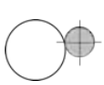
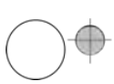
RELATIONSHIP	DESCRIPTION	CASES
Equals	City is the same as Campus. It includes those areas that were newly built as towns and/or cities. These were built and planned from scratch to accommodate clusters of technology. They are located only in Asia.	4/39
Contains	City contains Campus. It includes those areas that are inside the urban fabric but they are perceived as distinct campus with borders.	12/39
Overlaps	City and Campuses have multiple points in common. It includes those areas that integrate with the urban fabric and in many cases the borders between the sites and the city are not clearly defined or perceived.	6/39
Touches 	City touches Campus. It includes those areas which are located in a border condition in relation with the city. In most of the cases, they are located at the edge of the city. In some cases, they are in the city but their locations hold a border condition e.g. separated by a river, or a highway.	17/39
Disjoints 	City shares nothing with the Campus. It includes those areas located in areas outside the city borders but are not a distinguished as independent cities itself.	8/39

Table 6.2 Five types of topological relationships between the campus and the city.

Second, this description recognises the position of the technology campuses in relation to specific elements of the city or region as relevant in this research (e.g. university campus, core city centre, and airport). Accordingly, most technology campuses locate within 30 minutes from university campuses by means of public transportation. Moreover, nearly the half of the sites analysed are university campuses. Thus, a large number of technology campuses are located within one kilometre or a walking distance of fifteen minutes from a university campus. In comparison, this is predominant in campuses located in cities that contain and disjoint them. The largest distance to a university from a technology campus is 32 km and happens to be in a campus located in a city that disjoints it. An overview of the positions of the sites in relation to global knowledge clusters is illustrated in Figure 6.3.

Furthermore, most technology campuses locate in places that can be accessed from the city centre of their hosting cities within 60 minutes using public transportation (i.e. 39 minutes on average). Besides, at least the half of the sites studied can be reached within 30 minutes from the core of their hosting cities by public transport or walking (See Figure 6.4).

Last, the travelling distances of technology campuses from airports are rather varied compared with the distance to the other places analysed (range= 20 - 180 minutes). At least half of the campuses studied can be accessed from an international airport within one hour by means of public transport (i.e. 78 minutes on average). The distance of technology campuses to international airports is illustrated in Figure 6.5.

Equals

City is the same as Campus

This group includes four areas that were newly built as towns and/or cities. These four cases are located in Asia and were planned and built based on wide government initiatives between the years 1957 and 1986; one during the period regarded as the Atomic Age and the remaining three during the Spatial Age and the ICT Industrial revolution. All of them have been conceived as very new areas to encourage academy and sciences. Nowadays, two of them have been designated as special zones for economic development in their hosting regions. Due to their large scale, they accommodate one or more cases recognised as science parks, industrial parks, university campuses, and/or development areas. The clusters these cases accommodate are focused on R&D mainly on Information Technologies and Biotechnology.

1957 - 1986

#	CODE	NAME CITY - REGION
4	AAT	Novosibirsk, Siberia, RU
11	TSC	Tsukuba, Ibaraki, JP
14	TST	Daejeon, Hoseo, KR
21	ST-IPT	Sendai city, Miyagi prefecture, JP

Strategic Data

- The ambitions framing these four cases are originated at national scale and they all pursue 'Innovation' (Scientific or Industrial) as source for economic development.
- The cases of this group, which are in fact towns or cities, are developing specific measures to attract business and promote themselves in an international context. Some of these zones give advantage on regulatory standard requirements and financial help from governmental body and local autonomy.

Financial Data

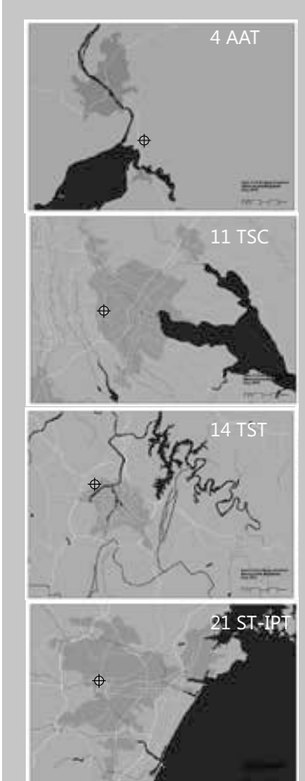
- Originally, these four cases are funded with public capital only. Nevertheless, changes in their socio-economic contexts have evidenced the influence of private capital in their developments. In most of the cases, public and private parties have initiated cooperation but the funding structures of the cases seem to be in transition since their partnerships are not officially established as a recognised institution. However, they present themselves as such.
- In most of the cases (with the exception of Akademgorodok) the management unit that control the cases is clearly defined by a management unit. However, they are diverse.
- The regions and/or countries are official promoters of the cases in this group addressing them as pillars for their economic development. In two of the four cases especial promotion bodies has been set up which are actively and formally marketing the case.

Functional Data

- The mean population accommodated in these cases is 100.000. Nevertheless, their composition is varied given the diversity of the data found. For instance, the population of Akademgorodok (70.000) and Tsukuba (214.000) is measured by the amount of residents (including students and researchers), while in Deadeok (62.689) and Sendai (53.431), this data is found by the amount of employees.
- The amount of organisations accommodated in these cases is also varied in number and types. For instance, these cases accommodates between 59 up to 550 companies. They all accommodate at least one university and several research institutes and centres.

Physical Data

- According to their perceived physical boundary, all the cases of this group are perceived as Large-scale cases.
- Their size in area vary widely ranging from 1.000 ha (Sendai) to 28.500 ha (Tsukuba).
- They all have nearly the same distance to the closest airport (50km) with the exception of Daedeok (150km).



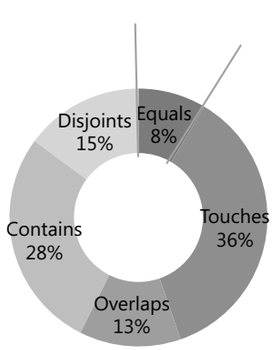


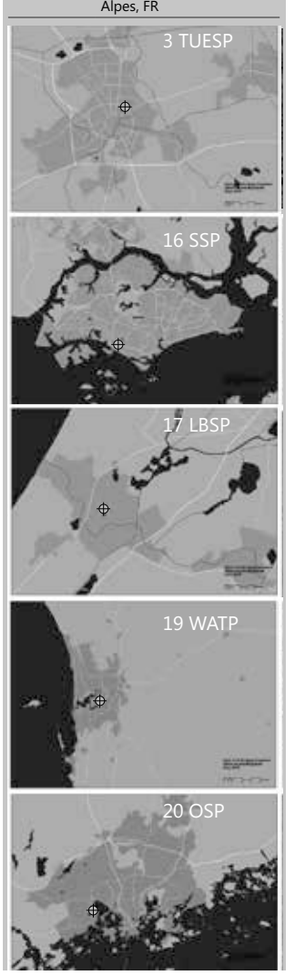
Fig.6.2a Description of technology campuses classified as Equals

Contains

City contains Campus

1957 - 2009

#	CODE	NAME CITY - REGION
3	TUESP	Eindhoven, North Brabant, NL
16	SSP	Singapore City-State, SG
17	LBSP	Leiden, South Holland, NL
19	WATP	Perth, Western Australia, AU
20	OSP	Espoo, Greater Helsinki, FI
25	BTUC	Cottbus, Brandenburg, DE
28	BAHU	Berlin, Brandenburg, DE
29	SHIP	Shenzhen, CN
30	TSP	Tainan City, TW
32	SPA	Amsterdam, North Holland, NL
33	BPS	Singapore City-State, SG
37	BCK	Barcelona, Catalonia, ES
38	GIANT	Grenoble, Isère, Rhône-Alpes, FR



This group includes 13 areas located inside the urban fabric, but they are perceived as distinct cases from the city. These cases are mainly surrounded by physical elements that create boundaries between them and the cities (e.g. main roads, fenced walls, distinct shapes of the built environment or specific access points disconnected from the main city structure).

Most of these areas have kept their official denomination, mainly Park or Campus. The type of cluster base they represent are, for the most, R&D clusters (16 in total out of 17) in combination with Scientific or fundamental research (6 in total) and a small share in combination with Production (4 in total), which is possible giving their border conditions at the edge of the cities. This is the case of two areas in Asia and two in Europe (one of these combines only small production). The research areas of these clusters are very diverse. Nevertheless, Biotechnology is addressed in the majority of the cases (10 out of 17) as the most common research field, as well as Energy & Health, Electronics, ICT and Materials. An important observation is that in nine cases, the cities hosting these campuses addresses Biotechnology, Health or Life Sciences as a key or emergent sector for their economic development.

These areas accommodate different types of research clusters. Most of them are R&D clusters (11 cases) in combination with scientific research clusters (7 cases) and/or Production clusters (3 cases). Equally, these three production clusters are located in Asia (Taiwan, China and Singapore). The fields represented in these research clusters are also varied in most of them, with exception of two cases, which specialize in Biotechnology (Biopolis Singapore), and Medial life Sciences (Leiden Bio Science Park). For the most, they are combinations of these major fields: Biotechnology, Health & Life Sciences (11 cases); ICT (7 cases); (Energy (6 cases); Materials (4 cases); Electronics (4 cases); Mobility (2 cases)

Strategic Data

- Few cases (5 out of 13) have an intended strategy as a framework for their development.
- Innovation and economic growth are the main drivers in the strategic ambitions of these cases. The most sounded concepts aimed to achieve their strategic goals are Cooperation (7 cases); International Attractiveness (4 cases); Urban Integration (4 campuses).
- In contrast to the cases, most of their hosting cities (10 out of 13) have designated strategies (e.g. plans, policies, visions, etc). The ambitions are diverse and combined but most of them are based on Differentiation, Strong Economy, and Competitiveness.
- The concepts the hosting cities in this group are using to accomplish their ambitions are diverse and they use combinations of concepts. The following are the most common: Attractiveness (5 cases); Knowledge (3 cases); Science & Technology (3 cases); Sustainability (3 cases); Innovation (2 cases); and Cooperation (2 cases).

Financial Data

- In contrast to the previous group, the cases in this group are predominant funded with public capital. Seven of the cases have been developed with public funding and are owned or supported by national or municipal governments. These cases are mainly in Asia-Pacific (Singapore, Taiwan, China and Australia). Nevertheless, two European cases were found both in Germany, and in the same region Brandenburg. The other funding structures are more represented by both public and private funding (5 cases in which 3 official partnerships have been established). Only one case is funded with just private capital, which is the case of Eindhoven University of Technology, originally public funded until 1995 when ownership of the campuses was transferred from the Dutch government to the institutions.
- The management structures that control the cases in this group are clearly defined except from one case (GIANT Innovation Campus). These management structures are equally represented by real estate management units (in 5 cases) and wide central management units in charge of other tasks besides the management of the built environment (in 6 cases). Depending on the cases, these last types of controlling units are part of external governing bodies at municipal or national level or their compositions involve several external parties. These two examples are correspondent with the cases that have Public and PPP funding structures respectively.
- External governing parties, from municipal to national scale levels, actively promote most of the cases in this group (at least 10 of them). Few of them have established designated marketing bodies to promote these cases. Those are the cases of Otaniemi Marketing in Espoo and Brainport Development in Eindhoven, an agency represented by members of the triple-helix, including the university, which task is to drive the region forward and make the economy of the region 'future proof'. This agency is marketing several campuses in the region.

Functional Data

- The mean population accommodated in the cases in this group is 24.600. Nevertheless, the differences between the populations of the case are large, varying from 1.156 (Brandenburg Technical University Campus in Cottbus) up to 74.000 (Shenzhen Hi-Tech Industrial Park in Shenzhen). These differences seem to be relative to the size of their hosting cities. In fact, the larger populations accommodated in this group refer to two cases in Asia and one case in Europe. This is the case of Barcelona City of Knowledge, which density of its hosting city is the largest of the group.
- The population accommodated in these cases is mainly represented by the amount of employees in the cases. Only six cases count the student population.
- The number of organisations in these cases varies also widely. Its variety ranges using the same examples from 14 (Brandenburg Technical University Campus in Cottbus) up to 1.200 organisations (Shenzhen Hi-Tech Industrial Park in Shenzhen).
- The types of organisation accommodated in all the cases are mixed. The most represented type is 'companies'. Only Brandenburg Technical University Campus in Cottbus does not register a company accommodated on campus. Likewise, three campuses do not accommodate universities and they are the three research production clusters located in Asia (Shenzhen Hi-Tech Industrial Park; Tainan Science Park and Biopolis)

Physical Data

- In relation to its urban context, the scale of these cases is mostly perceived as medium to small campuses. At least eight of them are perceived as areas which are part of the city. The remaining 5 cases are seen as portfolios or group of buildings in defined areas.
- The areas occupied by the cases in this group ranges from 30 ha up to 1150. Again, the extreme cases are the cases located in Cottbus and Shenzhen respectively. Thus, affirming that size is relative to the context. However, it is observed that the majority of the campuses (8 of them) occupied no more than 100 hectares.the scale and the mobility patterns in the different regions.

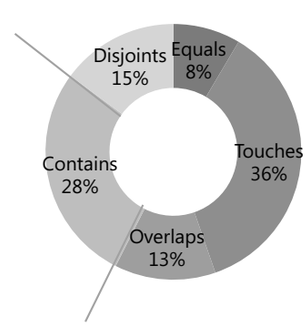


Fig.6.2b Description of technology campuses classified as Contains

Overlaps

City and Campuses have multiple points in common

This group includes six areas which settlements are (partly) integrated in the urban fabric of their hosting city. In many cases the boundary of the cases is not clearly defined or perceived. Thus, the physical infrastructure of these cases (e.g. roads, public space, parks and water, buildings, etc.) and that of the city have multiple points in common. This relationship is also present in some cases included in the previous group (City Touches the Campus). Three of the cases 'touched' by the city, have already multiple commons with the city (Stanford Research Park, TU Delft District & Technopolis and Innovation Campus Delft; and Hsinchu Science and Industrial Park). This group is evenly distributed among the three regions where the total sample is located: 2 cases in North America; 2 in Europe and 2 in Asia-Pacific. The first four campuses are owned by universities. They all are built before the Digital age, between 1951 and 1988. MIT Campus is part of this sample since major developments in this campus - settled in Cambridge since 1916- took place during the 1960s and the development of University Park at MIT in 1983.

Most of the areas present combinations of R&D clusters with Scientific research or Production. The production clusters are located in the two Asian cases that are part of this group. The campuses in group 3, accommodate research in a variety of fields. Thus, most of them focus on the fields of Biotechnology (5 cases); Electronics (3 cases); ICT (3 cases). It is outlined, the presence of Design and Engineering research in two of these cases. Correspondingly, High-tech business is addressed as a consolidated and/or key sector in the economic base of five of the hosting cities of these campuses. Likewise, creative industry is addressed as a key industry in two of them.

Strategic Data

- Two out of the six cases have an intended or defined strategy. These are campuses of universities of technology (MIT and TU Delft)
- The driving concepts more popular in the strategic ambitions of these cases are Innovation, Collaboration, Sustainability and Knowledge & Technology as source of economic development.
- The hosting cities of these cases have intended knowledge or innovation-based strategies (e.g. policies, visions, plans) with the exception of the two American cities.
- The most popular drivers for the strategic ambitions of the hosting cities in this group are innovation, competitiveness & attractiveness, diversity, entrepreneurship and knowledge.

Financial Data

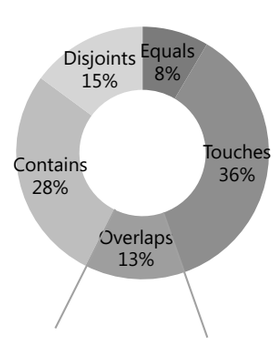
- The cases in this group are predominant funded with private capital. Three of the cases have been developed with private funding and are owned by universities; one with public funding and the two remaining have both public and private funding, from which, one is officially constituted as a public private partnership. University boards manage these three private funded campuses.
- All campuses have defined management units. Established real estate management units control the three private funded campuses. Centralised units that also perform other tasks besides real estate management manage the remaining three campuses.
- In the European and Asian cases, the hosting cities and/or regions of these cases are actively promoting them as flagship in their strategies. In some cases, they are actively involved in the spatial development of these campuses. On the contrary, in the two American cases, their hosting cities play a passive role as promoter in branding and marketing those areas as business location due to their international reputation.

Functional Data

- The population of the cases in this group varies from 15.500 (Leiden Bio Science Park) up to 131.168 (Hsinchu Science and Industrial Park). Excluding the two Asian cases, the population of these cases is rather similar with a mean of 21.900 people approx. studying and/or working on these campuses. Similarly, the population of the hosting cities is similar in the American and European cases. These cities have population from 66.000 to 106.000 inhabitants approx.
- The number of organisations accommodated in this cases varies largely from 16 (MIT campus and University Park in Cambridge) up to >2.000 (Zhong Guan Cun Science Park Beijing) organisations. The large difference might also be related with the regional context. Overall, most of the cases accommodate companies, except from MIT campus due to MIT's tax-exemption status. Similarly, most of them accommodate universities except from Hsinchu Science and Industrial Park.
- The knowledge base of the hosting cities of these campuses is strong. All of them host at least a university. Indeed, these 6 cities hosts four universities ranked in the Top 100 university rankings (THE higher education university rankings 2011-2012). In the two American cities, the universities are the top employers per number of staff (e.g. Stanford University in Palo Alto and Harvard University and MIT in Cambridge). In fact, these three are within the top 10 universities. In the two European cities, Education is one of the top employers sector in this cities.
- Only three campuses accommodate residential functions besides the central facilities with amenities and sports.
- The majority of the cities hosting the campuses in this group are rich in cultural amenities such as heritage buildings.

Physical Data

- The scale of the campuses in this group is mostly medium size. They are perceived as areas that are part of their cities. Only one of the six campuses is perceived as a large-scale size, in which the overall is perceived as a large part of the city. This is the case of Zhong Guan Cun Science Park Beijing.
- The area they occupied in the cities differs largely from 68 ha up to 7.500 ha.
- Similarly, as in the previous group, the transportation means offered by their hosting cities is diverse depending on the scale and the mobility patterns in the different regions.
- In terms of distance, all the campuses are in proximity to a university. Four of them host universities. The maximum distance from the cases to the universities is 4km and 30 minutes by public transport. In relation to the city centre, almost all of the cases are within 5km distance except from Zhong Guan Cun Science Park Beijing. In some cases (e.g. TU Delft, Cambridge), the city centre can be reached from the campus by walking distance of 10 minutes on average.
- The international accessibility by airport is varied. The distance from these cases to their regional airports varies from 8 up to 50 km. Most of them are accessible within an hour by public transport except from Hsinchu Science and Industrial Park.



1951 - 1988

#	CODE	NAME CITY - REGION
1	SRP	Palo Alto, California, USA
8	MIT - UP	Cambridge, Massachusetts, USA
10	TUDTIC	Delft, South Holland, NL
15	HSP	Hsinchu City, Northwestern Taiwan, TW
17	LBSP	Leiden, South Holland, NL
23	ZGCSP	Beijing, CN

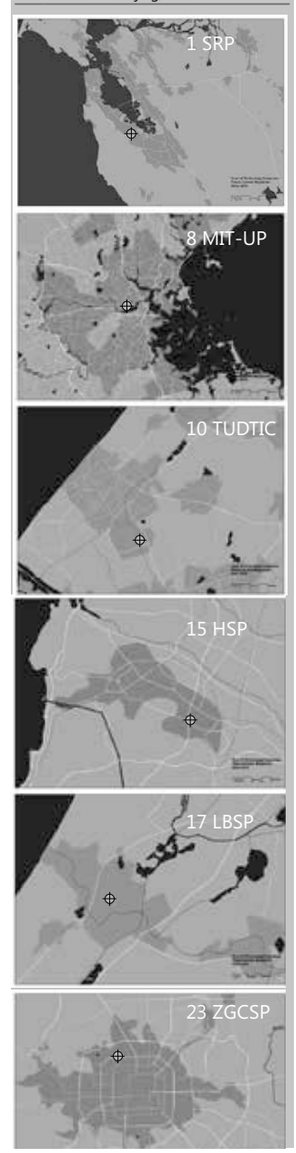


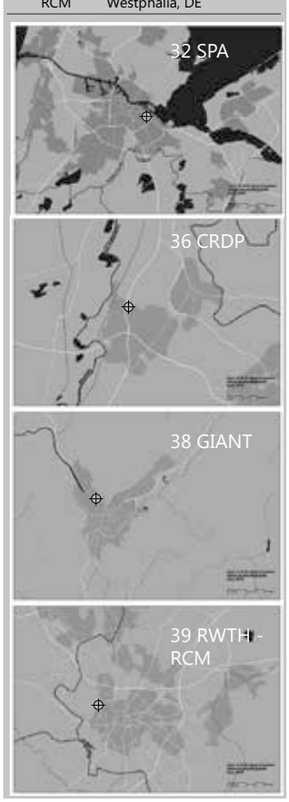
Fig.6.2c Description of Technology campuses classified as Overlaps

Touches

City touches Campus

1951 - 2011

#	CODE	NAME CITY - REGION
1	SRP	Palo Alto, California, USA
2	CBTP	Ithaca, New York, USA
7	ETHSC	Zurich, Zurich, CH
8	MIT - UP	Cambridge, Massachusetts, USA
9	DCUT	Enschede, Overijssel, NL
10	TUDTIC	Delft, South Holland, NL
12	CSP	Cambridge, Cambridgeshire, UK
15	HSP	Hsinchu City, Northwestern Taiwan, TW
16	SSP	Singapore City-State, SG
18	SYRP	Guildford, Surrey, UK
24	TPUB	Bremen, Bremen, DE
26	ZJHTP	Shanghai, CN
28	BAHU	Berlin, Brandenburg, DE
29	SHIP	Shenzhen, CN
31	HTCE	Eindhoven, North Bravant, NL
32	SPA	Amsterdam, North Holland, NL
36	CRDP	Sittard-Geleen, Limburg, NL
38	GIANT	Grenoble, Isère, Rhône-Alpes, FR
39	RWTH-RCM	Aachen, North Rhine-Westphalia, DE



This group includes 17 areas that are located in a border condition in relation with the city. In most of the cases, they are located at the edge of the city. In some cases, they are in the city but their locations hold a border condition e.g. separated by a river, or a highway. For the first kind, it can be said these areas were built outside the city centres but because of the urbanisation process, the urban fabric of the city is reaching their locations. As the urbanisation process, this border condition of technology campuses is observed at a global scale. In fact, the sample of this group is representative of the total. Overall, nearly the half of the total sample falls in this group and it is similarly distributed per region, with 2 out of 4 cases in America; 4 out of 14 cases in Asia-Pacific; and 11 out of 21 cases in Europe. These areas were built between 1951 and 2011: three of them during the period regarded as the Post-war & Atomic age; six of them during the space age & ICT industrial revolution; and 8 during the Digital & Information age. Thus, if half of these campuses have been built after 1989, their border condition in relation to their hosting cities might tell us something about the speed of the urbanisation processes in some places (e.g. Shanghai or ShenZhen) or the intention of locating these campuses in a convenient distance from the city centre.

Most of these areas have kept their official denomination, mainly Park or Campus. The type of cluster base they represent are, for the most, R&D clusters (16 in total out of 17) in combination with Scientific or fundamental research (6 in total) and a small share in combination with Production (4 in total), which is possible giving their border conditions at the edge of the cities. This is the case of two areas in Asia and two in Europe (one of these combines only small production). The research areas of these clusters are very diverse. Nevertheless, Biotechnology is addressed in the majority of the cases (10 out of 17) as the most common research field, as well as Energy & Health, Electronics, ICT and Materials. An important observation is that in nine cases, the cities hosting these campuses addresses Biotechnology, Health or Life Sciences as a key or emergent sector for their economic development.

Strategic Data

- The drivers behind the strategic goals of these 17 cases are diverse. It is observed that the economic driver based on innovation and entrepreneurship is the most popular among them. In 14 cases, these two topics are mentioned in their defined strategies, ambitions, or mottos. Other topics key addressed as common are Urban attractiveness (5 cases) and Sustainability (2 cases).
- In several campuses (10 out of 17), the city or the region is mentioned as an important part linked to their general ambitions.
- Some campuses, internationally known as successful cases (e.g. Stanford Research Park or Cambridge Science Park) do not state an intended campus strategy. Only a motto, apparently denoting the reason of their successes or their branding, is found. For example, 'Great ideas growth here' in Stanford is presenting the campus as the core of the Silicon Valley's growth; or '40 years of Innovation' in Cambridge. No link to their regional or urban contexts is addressed in the sources found in this exploration.
- All the cities that host the campuses in this group want to become an attractive city. The primary concepts of their strategies are varied and based on combinations of topics. Few of them appear to be commonly addressed: Technology as core of Innovation (8 cases); Sustainability (7 cases); Collaboration (5 cases); Diversity (5 cases); Knowledge (4 cases).

Functional Data

- The mean population accommodated in the cases of this group is 25.400 approx. Nevertheless, the difference among the cases is large, ranging from cases that accommodate 1.185 employees (Chemelot Campus) up to 131.168 employees (Hsinchu Science Park). This difference is relative to the size of their hosting cities. When comparing these two, one can also notice the difference in populations (Sittard-Geleen: 93.000 and Hsinchu: 393.000) and densities (Sittard-Geleen: 1,217 inh./sq km and Hsinchu: 3,952 inh/sq km) of both cities.
- The number of organisations accommodated in these cases also varies widely from 10 (ETH) up to 1.200 (Shenzhen). Nevertheless, when looking at the composition of these organisations it is observed that all the campuses accommodate companies but only 11 accommodate universities and 7 of them accommodate research institutes. Yet, their hosting cities seem to have a proper knowledge base since all the cities host at least a university. Indeed, six of them host a university in the Top100 rankings (THE university rankings 2011-2012).
- Besides the common leisure, cultural or sport facilities present in most of the campuses, ten of them offer residential areas (e.g. student housing, residential districts for researchers or hotels). Some cases, addresses residential areas in their planning.
- Comparing hosting cities and their functional attractiveness was difficult, for this group considering the sizes and characters of these cities are very diverse. They range from university towns (e.g. Cambridge, Ithaca, Delft, or Aachen) up to capital and/or global cities (e.g. Amsterdam, Berlin, Shanghai, or Zurich) and their amenities offering widely differs among them.

Financial Data

- The funding of this group of campuses comes from different sources. Funding from only private capital (6 campuses) is more dominant in this group than only public capital (3 campuses). Nevertheless, a combined public and private funding is observed as relevant in this group. For instance, 7 campuses are funded this way, from which, 3 official Partnerships are established. In some cases, these partnerships are not clearly established as source of funding since collaboration among partners just started as result of changes in their contexts. An example of this is the transitions observed in the Innovation Campus Kennispark Twente in Enschede. For instance, the Foundation Kennispark Twente is a joint initiative of the University of Twente, the City of Enschede, the Region of Twente, the Province of Overijssel and the Saxion University of Applied Sciences. The University of Twente and the City of Enschede have partnered up to make sure the area becomes and stays a state of the art innovation campus and have initiated several projects. The University of Twente and its campus was originally public-funded until 1995 when ownership of the campuses was transferred from the Dutch government to the institutions.
- The management units controlling these cases are clearly defined. Nevertheless, some distinctions are identified. In seven of them, the units responsible for their management are designated Real Estate units or departments. This is common in private funded campuses. The remaining ten cases are controlled by large and centralised management units responsible not only for the performance of the case but also combine tasks as the performance of R&D in these cases.
- In this group, the hosting cities/regions actively promote the campuses as pillars for their economies and participate in their planning. This is the case in eleven campuses.

Physical Data

- The scale of these 17 cases is perceived as uniformed and distributed in two groups from small (portfolio in an area) to medium (area in a district). Indeed, 8 of them are perceived as groups of buildings in a defined area, while the other 9 are perceived as areas that are part of the city.
- The mean area occupied by these cases in their hosting cities is 420 hectares approx. Nevertheless, the differences are large ranging from 47 ha (RWTH Aachen University -Research Campus) up to 2.500 ha (Zhangjiang Hi-Tech Park in Shanghai).
- According to the border condition of their locations, the accessibility of these cases seems to be an important issue. The transportation means offered by their hosting cities is diverse depending on the scale and the mobility patterns in the different regions. Despite the fact they are mostly accessible by car, all of them are covered in term of public transportation.
- In terms of proximity (distance), these cases are also diverse. The mean distance from these cases to the core city centre is 8km. They range from 1,5km (GIANT Innovation Campus in Grenoble, which border condition, is determined by its island location within the city) up to 25km (Zhangjiang Hi-Tech Park in Shanghai). They all are accessible from the city centre within an hour using public transportation. Similarly, the distance of these cases from their local airports varies from 6km up to 92km. All of them can be accessible from an airport in less than on hour by car and/or public transport. Some cases are exceptional such as Cornell Business & Technology Park served by its own airport on campus. Lastly, those campuses, which do not accommodate universities, are distant between 2 km and 25 km from them and all of them can be reached within 2 hours by public transport.

Fig.6.2d Description of Technology campuses classified as Touches

Disjoints

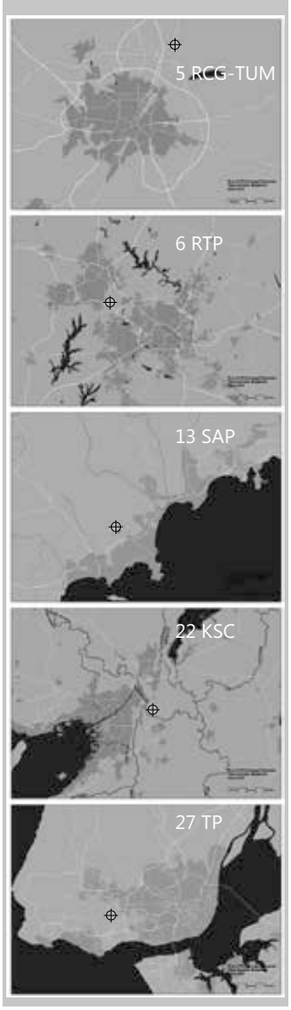
City shares nothing with Campus

This group includes seven cases located in areas outside the city borders but they are not recognised as a city itself. Some of them hold a title as unincorporated areas. This group have cases located in all the regions of this exploration: 1 case in North America; 4 cases in Europe and 2 cases in Asia. They are built in different periods from 1957 until 2005: 2 cases in the atomic age; 2 cases during the space age and ICT revolution; and 3 cases during the Digital and Information Age. The all have held a permanent name since their origins, except from one case that have change from Science City to a Strategic General Special Zone.

The research's clusters the cases in this group represent are singular types of cluster rather than combinations. Thus, it is predominant in this group the R&D cluster type (6 cases). One combination of R&D and Production is identified and one cluster of Scientific research. The predominant fields of research are similar to the ones present in the other groups: Biotechnology (5 cases); ICT (5); Electronics (4 cases); and Energy (4 cases). Likewise, the economic base of these cases is target at the following key sectors: Biotechnology (3 cities); High-tech businesses (3 cities) and IT (3 cities). Very few cities have a consolidated economic base in those sectors.

1957 - 2005

#	CODE	NAME CITY - REGION
5	RCG-TUM	Garching, Munich Metro Region, DE
6	RTP	The 'Triangle region' between Durham, Raleigh, and Chapel Hill, North Carolina, USA
13	SAP	Côte d'Azur Region, FR
22	KSC	Kansai [unincorporated city], JP
27	TP	Lisbon, PT
34	TCSP	Taichung,Central Taiwan, TW
35	BP	Cantanhede, Coimbra, PT



Strategic Data

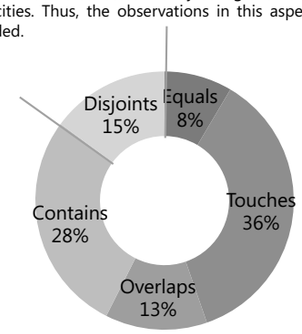
- Four of the cases in this group have an intended strategy. The main drivers behind their strategic ambitions are recognised as Sustainability (4 cases); Innovation (2 cases); and R&D (2 cases).
- Similarly, few of their hosting cities (4 in total) have an intended strategy. Nevertheless, the main drivers identified in their ambitions or goals are Knowledge (3 cities); Collaboration (3 cities); Innovation (2 cities). Few hosting cities in this group have vague strategic goals.

Financial Data

- The funding of the cases in this group comes predominant from Public and Private capital sources (6 in total, from which 5 have an official partnership structure). Only one of the cases in this group has funding from public capital.
- The controllers of the seven cases of this group are defined in management structures. The majority of them (6 in total) are managed by bodies conformed by several stakeholders who are in charge not only of the physical structure of the cases but they perform other task such as promotion of the research clusters and marketing of the cases. A Real Estate Management unit controls only one of the cases in this group. This one is a university campus funded by public and private capital without an official established partnership.
- Since most of these cases are PPP owned campuses, they are actively promoted and marketed by the agencies that control their assets, which are indeed, composed by several external stakeholders at municipal, regional, and even national levels.

Functional Data

- The mean population of these cases is 50.000 aprox. Nevertheless, the population of these cases is not normally distributed. It ranges from 210 (Biocant Park in Coimbra) up to 238.341 (Kansai Science City in Japan). These variations might relate to their contexts in terms of population and densities of their hosting cities.
- The population accommodated in these cases in mainly represented by number of employees. Only three cases possess data distinguishing number of students.
- The number of organisations accommodated in the cases also differs widely. The range is from 15 (Research Campus Garching – TUM) up to 1.400 organisations (Sophia-Antipolis Park). Similarly, the most represented type of organisations are companies (present in all the cases); and universities (present in 5 cases).
- Similarly to the previous group, the hosting cities of all the cases in this group has a knowledge based represented by more than one higher education institution including at least one university. Indeed, four of the Top 100 universities (The rankings) are located in the cities of this group.
- Only two of the seven cases have residential facilities accommodated on campus. These are hotels or congress-like facilities
- The amenities of the hosting cities in this group are difficult to analyse and compare since due to the location characteristics, the data is collected mainly at regional level from different cities. Thus, the observations in this aspect have been avoided.



Physical Data

- The scales of the cases in this group are very different. They range from small to large distributed as follows: 3 cases are perceived as small scale (portfolios or group of buildings in defined areas; one case is perceived as medium scale (an area that is part of the city); and r cases are perceived as large scale (large part of the city and in some cases, as the city itself)
- The mean area occupied by these cases in their hosting cities is 3.500 ha approx. Their land occupation area varies from 145 ha to 15.000 ha.
- The transportation means offered by their hosting cities is diverse depending on the scale and the mobility patterns in the different regions. Nevertheless, it is observed that in most of the cases (with few exceptions) these areas a car-dependant to be accessed efficiently. For instance, the distances described as follows were measured by using car as transportation means rather than public transport, which in some cases was not covered by the tools used in this exploration.
- In terms of proximity, these cases are within 32km to both universities and core city centre and 45' driving. Five cases accommodate universities, but depending on their size this distance is not always a walking distance and varies according to the departure point from which is measured (e.g. Research Triangle Part accommodates the TUCASI campus -Triangle Universities Center for Advanced Studies Inc. which is the home of the three Founding Universities Duke University, NC State University, and UNC-Chapel Hill. Though, considering the scale of this campus the proximity to these universities might vary).
- The proximity of these cases to an airport varies widely from 7 to 85 km of distance. The larger temporal distance to access the airport, from one of these cases is 1 hour and 40 minutes by car.

Fig.6.2e Description of Technology campuses classified as Disjoints

Fig.6.3 Global location of the technology campuses in this study (green) in relation to the location of knowledge clusters (blue). The latter is the mapping of 200 universities, which corresponds to the list of Top 200 universities in The Higher Education World University rankings 2011-2012 whereas, the larger circles represent the higher the rank in the list. It is important to outline that 63% of the universities in this list have campuses in urban locations.

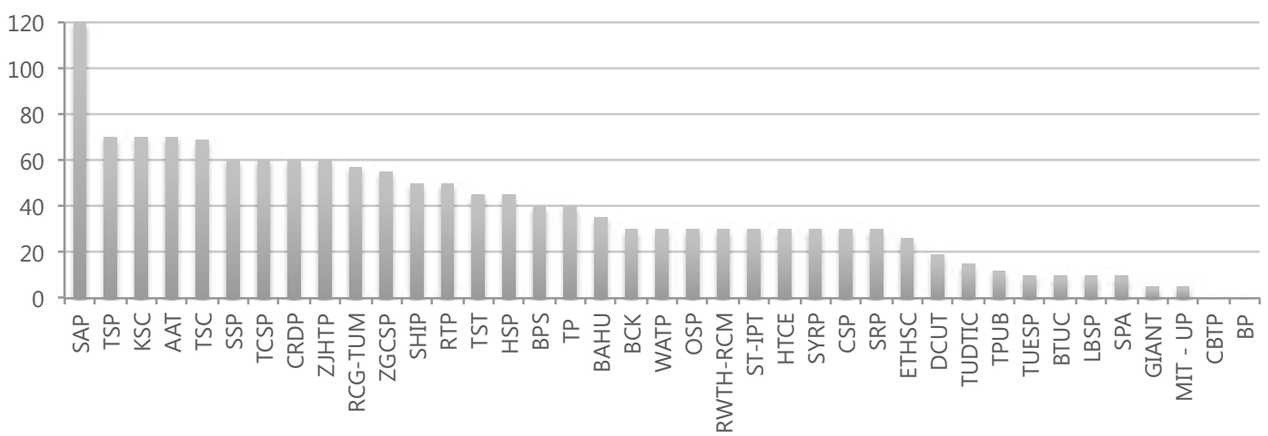


Fig.6.4 Overview of traveling distance (in minutes) from technology campuses to their nearest city centre with abundant amenities

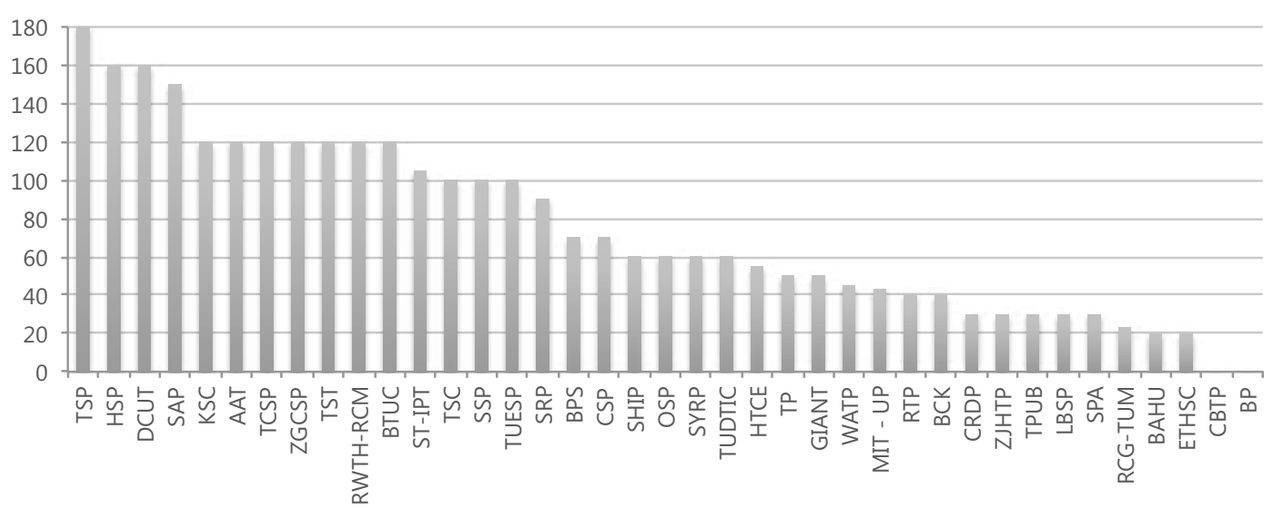


Fig.6.5 Overview of traveling distance (in minutes) from technology campuses to their nearest international airport

6.1.2. Layout patterns

Most technology campuses emphasize their character as clusters of built forms, which is dominated by compact and practical planning and design arrangements.

The ways in which buildings cluster in technology campuses varies widely from case to case depending on specific layout characteristics. The comparative analysis distinguishes two types of spatial layouts in technology campuses based on the relative physical proximity among campus buildings: compact and dispersed layouts. For instance, compact layouts are common in campuses that locate in relatively small to medium plots with semi-squared shapes, allowing walking distances of less than 30 minutes within the campus. On the contrary, dispersed layouts are arrangements in most large campuses, which plots have long shapes, making walking distances within the campus less convenient for its users.

Similarly, the organisation of clustered space distinguishes three functional layouts of technology campuses based on the perceived functional proximity among those buildings: diagrammatic, practical, organic layouts. For instance, diagrammatic arrangements present distinct shapes and spatial hierarchy. On the contrary, practical arrangements exhibit uniformity, rationality, and the use of straight shapes. Last, organic arrangements show also uniformity but the shapes are mostly results of specific geographic features of the plots.

Overall, most technology campuses in the sample studied have compact and practical layouts. Accordingly, there is a common pattern in arranging technology campuses in relatively small areas reached by walking distances, and in practical ways that the campus functions as a uniform and rational planned whole. An overview of the most common patterns of spatial and functional arrangements in technology campuses identified in this analysis is illustrated in Figure 6.6.

6.1.3. Size and density patterns

Technology campuses occupy large portions of land in cities and regions, which accommodate large and diverse populations with the possibility to expand in the future.

Technology campuses are defined first, by the concentration of tech-based research activities accommodated in a cluster of buildings; and second, by the variety of organisations carrying out these activities. Functionally, the supply of technology campuses is characterised by its end-users and their activities. The survey shows that technology campuses accommodate large populations (i.e. hundreds or thousands people depending on the size of the development). An important pattern identified is that campuses accommodate diverse organisations important for the knowledge base and economic base of cities in the knowledge economy (Van Den Berg et al., 2005). For instance, technology campuses accommodate at least two of type of tech-based research organisations (e.g. universities, institutes, and firms). Firms are the most common end-users of technology campuses according to this sample.

Besides, technology campuses accommodate the agglomeration of diverse research activities, both on the types of research (e.g. fundamental research or R&D) and the fields of focus. Indeed, R&D clusters -sometimes combined with basic research or production- are the common type of clusters in the sample studied. Biotechnology, Material sciences and Information technologies are the most common fields of research present in the sample of technology campuses studied.

Although there is a similar pattern in accommodating large populations, the number of people and organisations accommodated in technology campuses differ widely among subjects in the sample. For example, the number of users ranges from 210 up to 238.341 people. These variations among the campuses may relate not only to the different types of campuses but also to the varied population and densities of their hosting cities. The population accommodated in these campuses in mainly represented by the number of employees. Only three campuses possess data distinguishing number of students.

Similarly, the number of organisations accommodated in technology campuses differs widely among the sample (i.e. from 15 up to 1.400 organisations in a single campus). Nevertheless, the data and analysis techniques used in this study were limited to investigate the density of these built environments. Therefore, the data collected do not provide with information that characterise the density of technology campuses in a broad sense. Overall, the analysis of the sample emphasized that technology campuses are large clusters of people and buildings.

In this context, the size of the land occupied by technology campuses (its people and buildings) varies widely. Initially, campuses were distinguished according to their perceived scale in relation to its hosting city into large, medium, and small size. Nevertheless, based on data about the area occupied by technology campuses, the difference in size is vast (i.e. from 22 up to 28.500 hectares). Accordingly, the largest of the sample is indeed, a campus that is the same as a city. In order to compare, a reference to an existing area is used to identify a size range of technology campuses[21]. Although the size of technology campuses differs widely, most technology campuses are smaller than the reference used in this research. Nevertheless, a considerable number of technology campuses occupy thousands hectares in cities and regions. The diversity of sizes is illustrated in Figure 6.7 below.

Last, this study observed that the diversity of amenities offered in campuses relates to their size and locations characteristics. For instance, all campuses that were planned and built as cities provides residential space and supporting functions such as cultural amenities, sport and retail facilities. Similarly, those campuses in the outskirts of the city have central (congress-like) facilities with mixed functions (sometimes including hotels). An important pattern in the sample is that most cities hosting campuses are small to medium size cities, which have a significant knowledge base (e.g. prestigious research university or institute). Only six capital cities host campuses and since the late 1980s. This is important because large cities have the capacity to attract and retain knowledge workers easily than small cities. That is because of the quality and diversity in the provision of amenities besides having a good knowledge base.

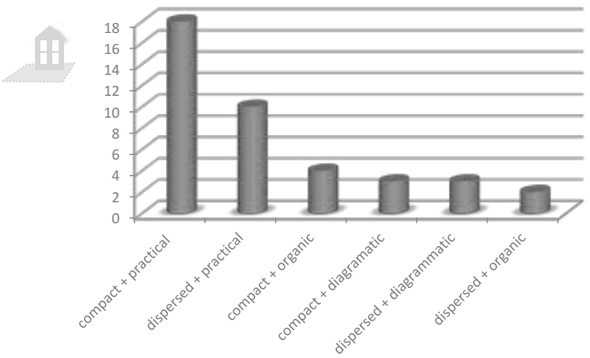
6.1.4. Block patterns

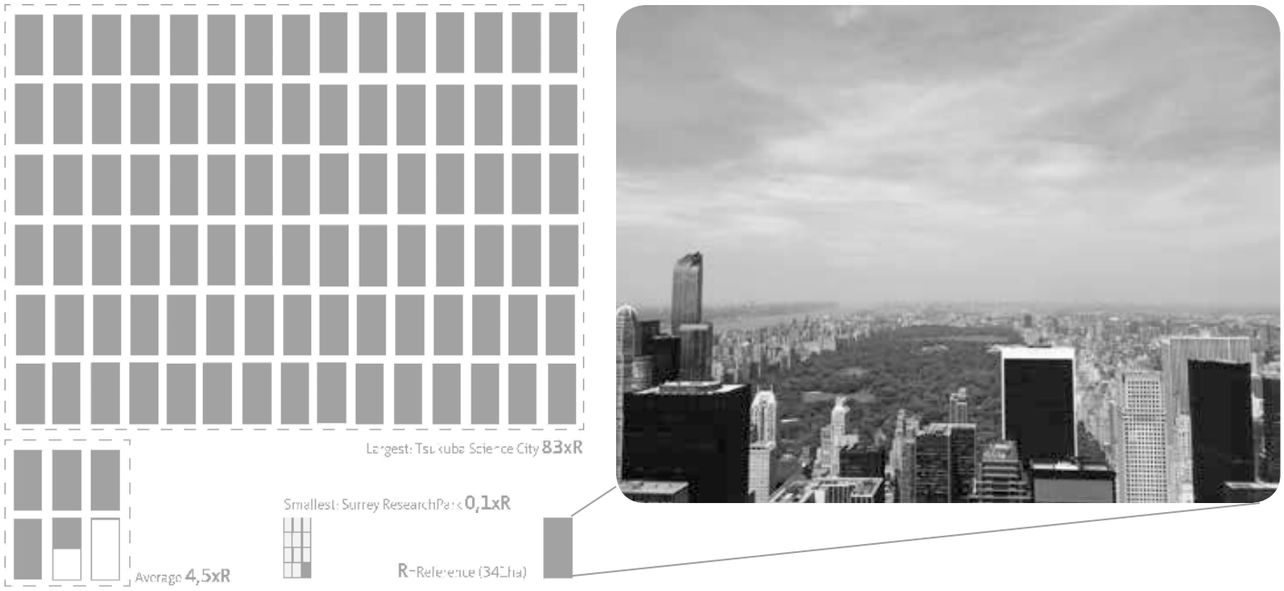
Technology campuses are designed and built with the idea of self-standing buildings in the green, making them introverted built environments regardless the influence of different planning models.

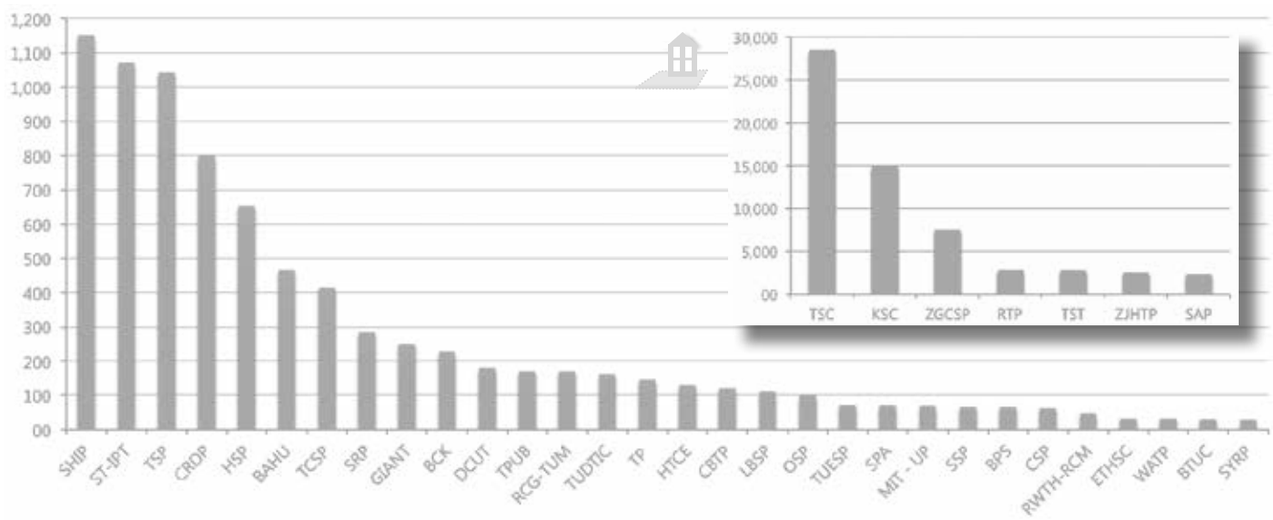
The block patterns of technology campuses are planned regular patterns with variations in the shape and configuration of the streets and the buildings. For instance, the free-standing building is the predominant building unit. The shapes and size of the buildings are diverse among technology campuses but in most of the cases, these buildings are arranged in an orthogonal configuration.

[21] This study used central park in Manhattan, New York as a reference for being a clearly defined area, which is well known and easy to identify by many. The surface of central parks is 341 hectares.

Fig.6.6 Overview of the patterns in the layout characteristics of technology campuses.







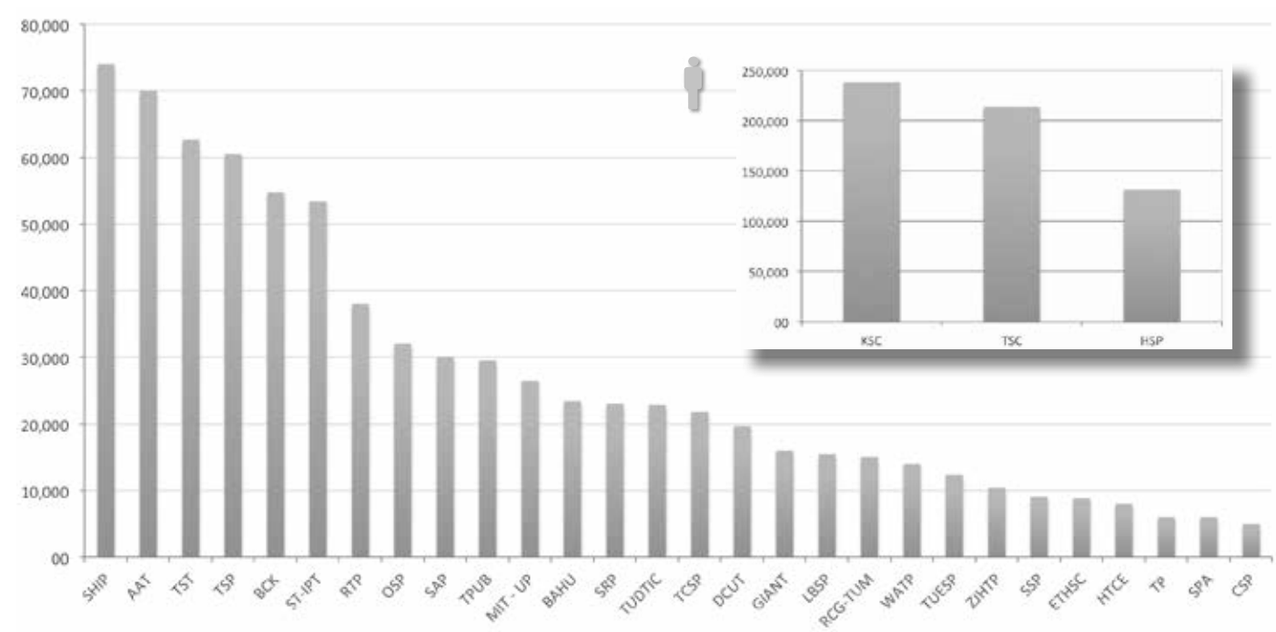


Fig.6.7 Above right: Different sizes of technology campuses in hectares compared to reference (R=Central Park in Manhattan, New York). Middle: size of technology campuses in hectares. Below: number of users in technology campuses.

Correspondingly, the configuration of the streets differs widely among technology campuses. For instance, four street features are found within the sample. The first two focus on the form of the street: (1) grid-shaped, and (2) irregular-shaped streets. The other two, focus on the function of the street: (3) continuous street pattern with an open road network, which is accessed as an integral part of the city; and (4) discontinuous street pattern with a closed road network characterised by designated access points at campus level and cul-de-sac streets for building accessibility.

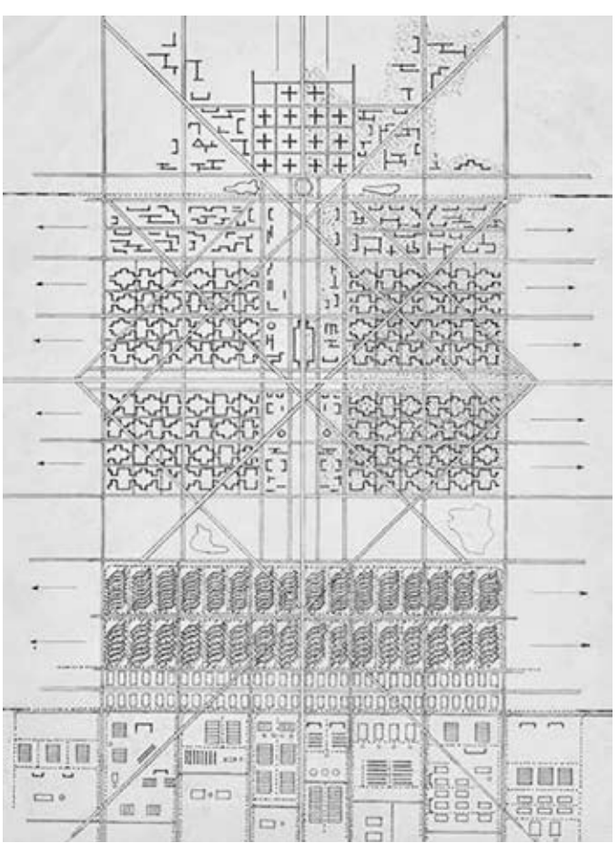
Based on these features, this research distinguishes two main types of block patterns that differ mainly on the continuity of the campus' street pattern from its urban context. The first block pattern in technology campuses is the super-block, which has a discontinuous street pattern or closed road network. As described in the Modernist era, in this pattern free-standing buildings are set in a green area organised and 'isolated' by a loose and maxi grid of high-speed arteries with different shape. In fact, this block patterns distinguish specific entrances to the sites.

The second block pattern in technology campuses is the multiple blocks of different sizes and shapes, which have a continuous street pattern and an open road network. Likewise, free-standing buildings are set in areas that are mostly green fields, but the street and its continuity with the city system is also defining the use of the land. This pattern is predominant in most technology campuses.

Overall, these patterns seem to be influenced by various planning principles applied in the design of new modern cities. For instance, the modernist theory of the Radiant City (Le Corbusier, 1933) can be identified through the comparative analysis. This is evident in those subjects that were built as completely new cities envisioned by national governments. Examples of those are Tsukuba Science City, developed by the Japanese government as a satellite city next to Tokyo (See Figure 6.8) and Akademgorodok developed by the former Soviet Union as an ideal academic town in Siberia.

Similarly, the spatial ideas of the Modern Cities can be also compared to contemporary aesthetics visions present in some technology campuses (Figure 6.9). Furthermore, the main idea of the English Garden City of having houses looking inward toward a central green in which the traffic is excluded and the use of a curvilinear road schemes is clearly recognised in some technology campuses (Figure 6.10). On the contrary, the principle of the small blocks is not clearly perceived due to the prevalence of free-standing buildings as main block pattern. Nevertheless, this can be more perceived in some campuses which block pattern follow the street configuration of its urban context (Figure 6.11).

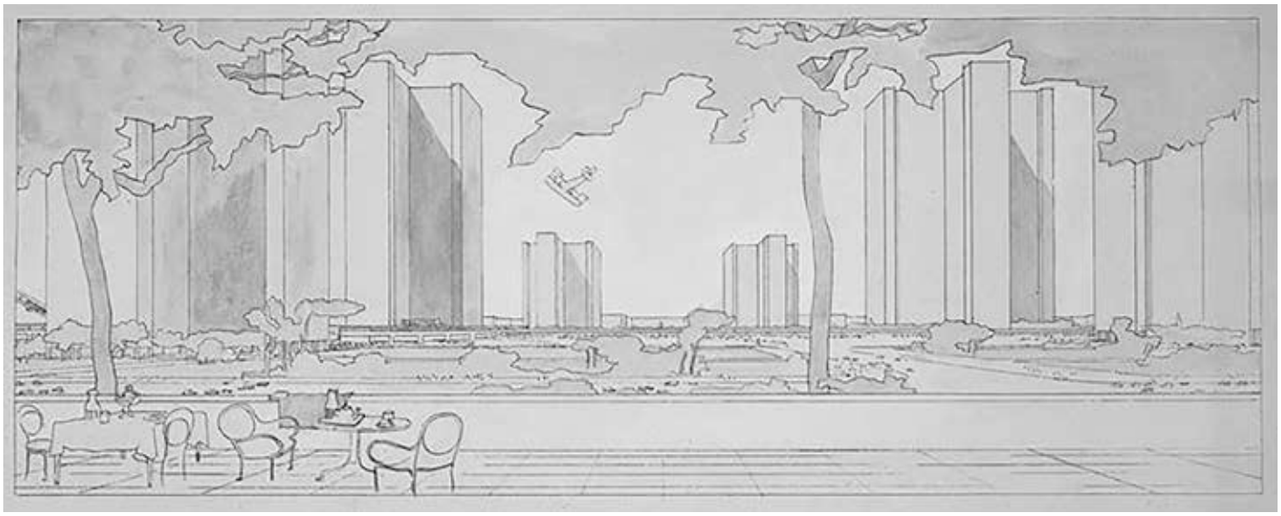
These examples illustrate how the built environment of technology campuses seems to be influenced by planning principles that have been used in the 20th century to develop new cities. Some of these principles have been highly criticised in planning theory and practice because it has generated introverted areas that depend on car accessibility and lack vitality. In fact, this can be seen in many technology campuses, whose arrangements correspond to these principles. For instance, in some technology campuses the buildings do not stand on the green as a group that accommodates interconnected organisations but as individual protagonist of a sterile green carpet.



a) Le Corbusier's 'The Radiant City' (1933) ©FLC-ADAGP

b) Core District of Tsukuba Science City. Map image: Esri 2013

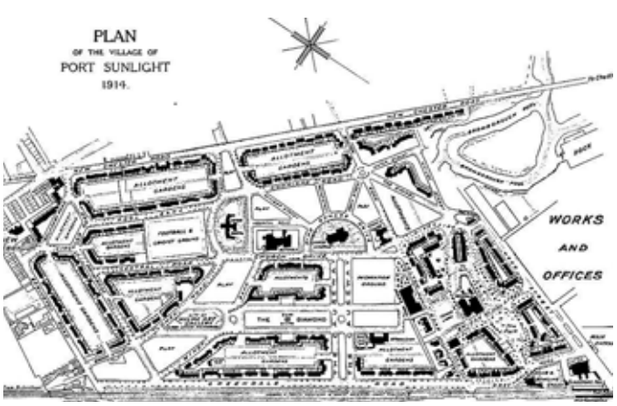
Fig.6.8 The idea of Le Corbusier's contemporary city (a) as 'a spectacle or order and vitality' is reproduced in Tsukuba Science City (b) with a central functional area like a forum, surrounded by green.



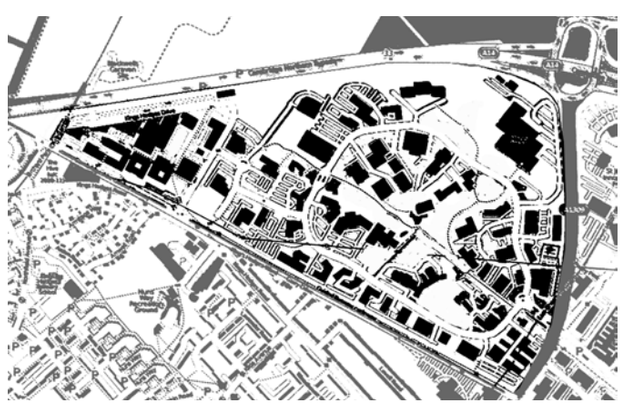
a) Le Corbusier's a contemporary city's vision ©FLC-ADAGP

b) Philips High Tech Campus Vision (Collage: Martine Nederend. Source: Philips High Tech Campus Vision, 1999)

Fig.6.9 Aesthetics similarities between Le Corbusier's a contemporary city's vision from 1933 (a) and Philips High Tech Campus Vision from 1999 (b). Large open spaces, green structures and uniform buildings dominate both ideas. 'We must built in the open...The city of today is dying thing because it is not geometrical. By using a uniform lay-out. The result of a true geometrical layout is repetition. The result of repetition is a standard, the perfect form.' (Source: The City of To-morrow and Its Planning, Le Corbusier, 1929, and Philips High Tech Campus Vision, 1999).

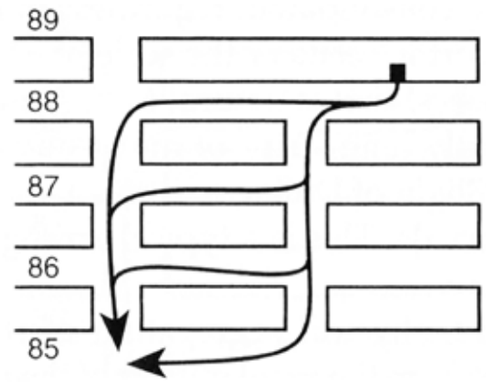


a) Plan of Port Sunlight, England (Davison, T., 1916)



b) Cambridge Science Park. © OpenStreetMap contributors (Edited)

Fig.6.10 The plan of Port Sunlight, England (a) as described in Kostof (1991) introduced for first time the idea of the superblock. It is observed the disposition of the buildings towards a central green area excluding traffic and the use of curvilinear road scheme. The same idea can be noticed in technology campuses such as Cambridge Science Park (b) in which the freely disposition of buildings in a curvilinear road scheme which are accessed through cul-de-sac streets safeguarding the central green area.



a) Movement across small blocks (Jacobs, 1961)

b) Northern area of Stanford Research Park,Palo Alto. © OpenStreetMap contributors (Edited)

Fig.6.11 The principle of small blocks described by Jacobs (a) can be distinguished in those campuses that follow the street pattern of their cities. For instance, a section of the northern part of the Stanford Research Park (b) has shown the influence of the urban street pattern in the campus (in this case the grid). Nevertheless, it also evidences the differences in block patterns when self-standing building is the main building pattern, in which the small grid starts to disappear the more the campus expands away from the city. This example illustrates that the size of the building is a relevant aspect of the block pattern of technology campuses.

Overall, the lessons from planning theory can be used to interpret the block pattern interrelated to the other characteristics of the built environment. For instance, the block pattern of the campus is linked to the layout, size, and location characteristics, in which the size and use of the building gains importance in the shape and configuration of technology campuses.

6.2. Chapter conclusions

Are there common patterns in the supply of technology campuses? What characteristics define the supply of technology campuses?

This study identified common patterns in the supply of technology campuses. These are distinguished when looking at both, the formal and functional characteristics accommodating the concentration of tech-based research activities. Accordingly, five main characteristics of technology campuses have been studied emphasizing the forms and functions: location, layout structure, size and density, block pattern, and appearance. Empirical and theoretical information is provided for the first four qualities. However, with respect to appearance only theoretical but no empirical evidence about its importance is provided in this exploration. These characteristics are summarised in Table 6.3 below. The four characteristics emerging from the empirical data are interrelated and altogether can be used to describe the supply of technology campuses as follows:

- **The location** shows most technology campuses (1) are found in industrialised regions: 54% in Europe and 10% in North America; (2) they have a border condition regardless its relation with the hosting city (87% of the sample); and (3) are near to (or in) universities' locations: 56% of the sample is within 15 minutes by foot and 71% of the sample is within 30 minutes by public transport. Similarly, the analysis of this characteristic shows 5 different relationships between campuses and their hosting cities/regions (Equals 8%, Contains 28%, Overlaps 13%, Touches 36% and Disjoints 15%). These relationships are associated with specific spatial dynamics in their contexts showing most campuses are in transition due to urbanisations processes (77% of the sample in the categories Contains, Overlaps and Touches).
- **The layout** emphasises the clustered character of technology campuses as built environments, which is dominated by compact and practical arrangements in their designs (46% of the sample). Nevertheless, the study of this characteristic also shows that although practical arrangement is very common in the design of campuses (71% of the sample)many campuses are also dispersed due to their large size (38% of the sample).
- **The size and the density** show technology campuses occupy large pieces of land intended to accommodate large populations in cities/regions. Together, technology campuses occupy 69.600 hectares (1.800 hectares on average). However, there are marked differences in their physical size (the surface of technology campuses ranges from 28 up to 23.800 hectares. The latter is Kansai Science City, an unincorporated city between three prefectures in Japan). In terms of users, the size of technology campuses is equally diverse. Together, they have 1,3 million users (3.700 users on average). However, the users' range is wide (between 210 and 238.000 users). Not surprisingly, the largest campuses in size and users are those considered as Equals (i.e. the campus is the same as the city). When looking at the density, one can say technology campuses have a relatively low density (99,5 users per hectare on average). The densest campus has 438 users per hectare while the least dense campus has one user per hectare.
- **The block pattern** shows that all technology campuses are designed and built with the idea of self-standing buildings on the ground as predominant building unit. The analysis shows an association between these patterns influencing planning principles of modern architecture during the 20th century. Examples of these principles are deliberated the use of orthogonal configurations (21 cases), grid-shaped blocks (14 cases), closed road networks (19 cases) and invisible superblocks (8 cases).

Overall, these characteristics are relevant campus planning and design aspects to focus the attention, considering their persistent association with theoretical concepts explaining innovation (e.g. proximity, accessibility, interaction, and diversity). Certainly, the descriptive nature of this research cannot tell whether these concepts have influenced the planning and design practices in technology campuses. However, the interrelationships between these concepts and the physical characteristics of technology campuses can be further investigated.

	FORMAL/FUNCTIONAL CHARACTERISTICS	LINKS WITH THEORETICAL CONCEPTS	EMPIRICAL PATTERNS
1	Location and settlement	Clusters, Competitive advantage, Proximity, Connectivity, Accessibility.	Five topological relationships with the city related to urban development in time (Equals, Touches, Overlaps, Contains, Disjoints)
			Predominant features: (a) located in industrialised regions, (b) border or isolated condition, (c) close proximity to universities, and (d) relative good accessibility to city centres.
2	Spatial and functional layout	Proximity (geographic, social and cognitive); face-to-face interaction; creativity	Two types of spatial layouts according to the physical proximity of buildings (compact and dispersed), and three types of functional layouts according to the functional proximity of buildings (diagrammatic, practical, and organic).
			Predominant features: (a) compact, and (b) practical layouts.
3	Size and Density	Social interaction, Proximity, Diversity (of people, ideas, buildings and functions).	Predominant features: (a) Diversity in the type of research activities and type of organisations accommodated in campuses; (b) concentration of diverse people; (c) variety of sizes which relevance is relative to the context of each campus.
4	Block pattern	Creativity; Small blocks and Chances of encounter and interaction; Diversity; Walk-ability; Accessibility	Two block patterns: superblock (with a closed road network), and multiple blocks of different sizes and shapes (with a open road network) /
			Predominant features: (a) planned regular block patterns; (b) self-standing building on the green as main building unit whereas the size of the building becomes relevant; (c) and diverse shape and configuration of the streets.
5	Appearance	Attractiveness of place; Added value of real estate (e.g. supporting image and culture)	Not available in data collected.
Source	Theories on the built environment (Architecture, Urban planning, Urban design, Real Estate Management)	Literature review on the role of the built environment in innovation (Urban economy, Urban planning, Real Estate Management)	Qualitative survey of 39 technology campuses

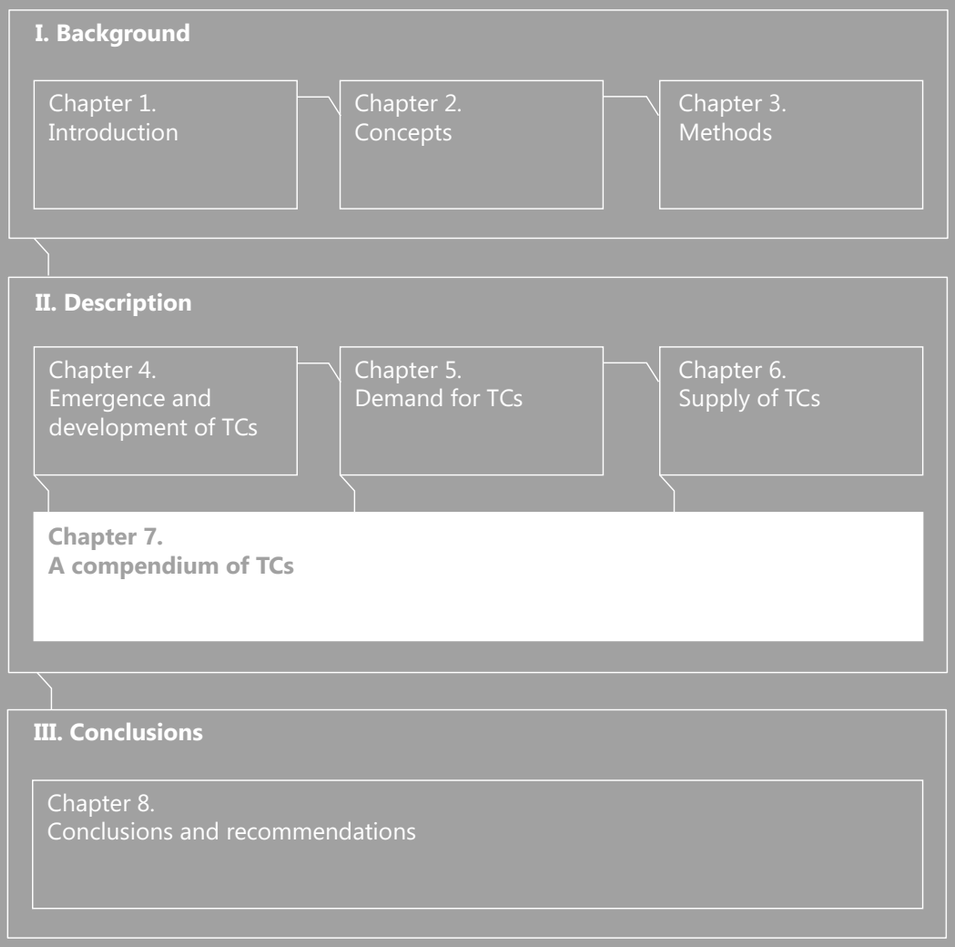
Table 6.3 Overview of formal and functional characteristics of technology campuses linking theoretical concepts and empirical patterns

technopoles creative factories science parks urban campuses technology parks science cities knowledge university campuses greenfield campus locations open university research park tech hightech innovation knowledge corporate campuses hubs campus campuses campuses quarters

technology campuses & cities

A description of built environments accommodating technology-based research

39 research sites 69.600 hectares 37 cities 16 countries 5 built form qualities 4 global regions 5 design/planning concepts 63 years of development 5 topological relationships 21 mixed sources of funding 6 spatial/functional layouts 2 block patterns 5 main 3 main stakeholders 5 context aspects ambitions 11 partnerships 1,3 million users 1 accommodation solution 3 stakeholders' roles


I. Background
Chapter 1.
Introduction
Chapter 2.
Concepts
Chapter 3.
Methods
II. Description
Chapter 4.
Emergence and
development of TCs
Chapter 5.
Demand for TCs
Chapter 6.
Supply of TCs
Chapter 7.
A compendium of TCs
III. Conclusions
Chapter 8.
Conclusions and recommendations

7. A compendium of Technology campuses

How do campuses compare to each other? This chapter summarised the descriptive data collected per each technology campus in a compendium. The compendium presented here organises the information in a way that is suitable to compare the similarities and differences between the many built environments that technology campuses entails.

This compendium contains the descriptive data for each of the thirty-nine campuses studied, as well as the contexts in which they have emerged and evolved. The data of this compendium is presented in single 'profile pages' for each of the campuses and their hosting cities. The data is organised into general, strategic, functional, and physical data according to the data collection procedures explained in Chapter 3. The general data is highlighted in a single column on the outside margin of each page. Symbols are used to identify the last four data categories in line with perspectives on campus management used in theories of Corporate Real Estate management theories.

Similarly, an additional reference is used to categorise the campuses according to their location characteristics as resulted from the analysis of the physical data (Equals, Contains, Overlaps, Touches, Disjoints). An example of a profile page for each campus is illustrated in Figure 7.1.

Fig.7.1 Example of profile pages per technology campus and type of data described

7.1. Abbreviations and symbols

Table 7.1 below presents a summary of abbreviations and icons used in each campus profile as descriptive information on the four perspectives of campus management. More details of the data is found in Chapter 3.

STRATEGIC DATA	
Vision campus and Vision city	(V1) Policy, Strategy or Plan: the name of the specific instrument were the vision of the cities and institutions are contained if available, (V2) Ambition and/or Goals: the general aim and/or specific aims containing in a vision if available, (V3) Concepts and/or Pillars: the core elements throughout the vision is implemented, and (V4) Motto or Slogan: the official words used to identify the core of the vision on their documents or websites.

FINANCIAL DATA	
City promoters	(Prom1) Official Promoter - the external stakeholders who are actively and formally marketing the campus. In some cases, these stakeholders are involved in campus decisions related to the provision of physical infrastructure in the vicinities of the campus. (Prom 2) Unofficial Promoters - the external stakeholders who informally market the campus as a positive brand for the economic development of the city.

FUNCTIONAL DATA	
Population campus	(P1) Employees: workers and/or staff including academic staff, and (P2) Student: in Bachelor, Master and PhD levels. In the case this data is not found, it is replaced by the data available and categorised as 'Other'.
Organisations campus	(O1) Companies: firms or multinational corporations (O2) Academic institutes: faculties, research institutes, and/or offices linked to a university and/or a higher education institution (O3) Other Institutes: research centres and institutes. In some cases, universities are part of these research institutes.
Tertiary education city	(U) Universities and (HEI) Higher education institutions (e.g. colleges and other institutes that are not regarded as universities). R indicates the university rank number in the Top 200 universities rankings (The Higher Education University Rankings 2011-2012).
Campus amenities	(F1) Shared facilities: mixed uses in one single facility (F2) Green & Sport facilities: sport halls and courts, landscape features, etc., and (F3) Residential & Care facilities: housing, hotels, day-care, supermarkets, etc. When these functions are planned and not realised yet, the data is categorised as 'F-Plan'. Other facilities that do not fall in these categories are addressed as ' F-Other'
City amenities	(A1) Cultural amenities: theatres and stages, music and concert halls, libraries, museums, art galleries, etc., (A2) Leisure amenities: Shopping centres and malls, retails districts, markets; restaurants, bars and pubs, etc.; (A3) Green & Sport amenities: parks, beaches, lakes, natural reserves, forests, sport halls, and centres.

PHYSICAL DATA	
Campus scale	(S) Small - Portfolio in an Area: the campus is perceived as a group of buildings in a defined area (M) Medium - Area in a District: the campus is perceived as an area that is part of the city (L) Large - District or Town: the campus is perceived as a large part of the city and in some cases, as the city itself.
Distance	The spatial distance is measure in kilometres and in minutes. These are calculated using three transportation means: Public transport Car Walking Public transportation is the preferred to measure the distance using Google data on public transport, which is limited to their coverage area, containing data on participating public transit agencies. In cases where this data is not available, car is used to measure the distance.

Table 7.1 Abbreviations and symbols describing technology campuses in the profile pages

7.2. Index of technology campuses

The following pages present a compendium of technology campuses by which each campus and its hosting city/region are presented in a separate profile page. The order of the campuses is illustrated in the Table 7.2 below. This order corresponds to the date of emergence. In some cases this date represents a significant period of campus development and it is outlined in the profile page.

NR.	CODE	NAME SUBJECT	NAME CITY - REGION
1	SRP	Stanford Research Park	Palo Alto, California, USA
2	CBTP	Cornell Business & Technology park	Ithaca, New York, USA
3	TUESP	TU/e Science Park	Eindhoven, North Brabant, NL
4	AAT	Akademgorodok Academic Town	Novosibirsk, Siberia, RU
5	RCG-TUM	Research Campus Garching - Technical University of Munich	Garching, Munich Metro Region, DE
6	RTP	Research Triangle Park	The 'Triangle region' between Durham, Raleigh, and Chapel Hill, North Carolina, USA
7	ETHSC	ETH Hönggerberg Science City	Zurich, Zurich, CH
8	MIT - UP	MIT Campus & University Park at MIT	Cambridge, Massachusetts, USA
9	DCUT	Drienerlo Campus University of Twente & The Innovation Campus Kennispark Twente	Enschede, Overijssel, NL
10	TUDTIC	TU Delft District & Technopolis and Innovation Campus Delft	Delft, South Holland, NL
11	TSC	Tsukuba Science City	Tsukuba, Ibaraki, JP
12	CSP	Cambridge Science Park	Cambridge, Cambridgeshire, UK
13	SAP	Sophia-Antipolis Park	Côte d'Azur Region, FR
14	TST	Taedok Science Town & Daedeok Innopolis	Daejeon, Hoseo, KR
15	HSP	Hsinchu Science and Industrial Park	Hsinchu City, Northwestern Taiwan, TW
16	SSP	Singapore Science Park	Singapore City-State, SG
17	LBSP	Leiden Bio Science Park	Leiden, South Holland, NL
18	SYRP	Surrey Research Park	Guildford, Surrey, UK
19	WATP	Western Australia Technology Park	Perth, Western Australia, AU
20	OSP	Otaniemi Science Park & Otaniemi Technology Hub	Espoo, Greater Helsinki, FI
21	ST-IPT	Sendai Technopolis & Izumi Park Town Industrial Park	Sendai city, Miyagi prefecture, JP
22	KSC	Kansai Science City	Kansai [unincorporated city], JP
23	ZGCSP	Zhong Guan Cun Science Park	Beijing, CN
24	TPUB	Technology Park Bremen & University of Bremen	Bremen, Bremen, DE
25	BTUC	Brandenburg Technical University Campus	Cottbus, Brandenburg, DE
26	ZJHTP	Zhangjiang Hi-Tech Park	Shanghai, CN
27	TP	Taguspark	Lisbon, PT
28	BAHU	Berlin Adlershof Humboldt University	Berlin, Brandenburg, DE
29	SHIP	Shenzhen Hi-Tech Industrial Park	Shenzhen, CN
30	TSP	Tainan Science Park	Tainan City, TW
31	HTCE	High-Tech Campus Eindhoven	Eindhoven, North Brabant, NL
32	SPA	Science Park Amsterdam	Amsterdam, North Holland, NL
33	BPS	Biopolis	Singapore City-State, SG
34	TCSP	Taichung Science Park	Taichung,Central Taiwan, TW
35	BP	Biocant Park	Cantanhede, Coimbra, PT
36	CRDP	Chemelot Campus	Sittard-Geleen, Limburg, NL
37	BCK	Barcelona City of Knowledge	Barcelona, Catalonia, ES
38	GIANT	GIANT Innovation Campus (Grenoble Innovation for Advanced New Technologies)	Grenoble, Isère, Rhône-Alpes, FR
39	RWTH-RCM	RWTH Aachen University -Research Campus Metalen [expansion]	Aachen, North Rhine-Westphalia, DE

Table 7.2 List of technology campuses selected for this qualitative survey

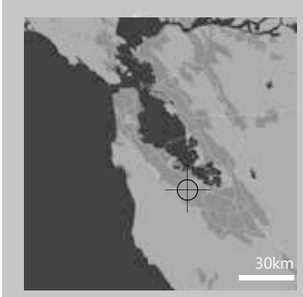
Stanford Research Park

Palo Alto, California, USA

Touches
Overlaps

Code: **1-SRP**

Year: **1951**



Official denomination:

Changed: from Industrial Park (origins) to Research Park (2013)

Named initially Stanford Industrial Park, was the first of its kind and became the cornerstone of what would eventually be known as Silicon Valley. Nowadays, called Stanford Research Park, is still home to the main headquarters of Hewlett-Packard and recently Facebook's headquarters. Since the early 1990s, many large American law firms have established Silicon Valley branch offices in or near the park.

Cluster base campus:

R&D: Mostly scientific, technical and research oriented in the fields of electronics, space, biotechnology, computer hardware and software.

Economic base city:

Consolidated: High tech businesses.

Ext. promoters: Prom2: City of Palo Alto play a role as promoter in branding and marketing for business location.

Vision city: V2-Goals: Encourage innovation and technology; Make the inner city attractive and vibrant; Encourage diversification of the economic base./ V4-Motto: 'Birthplace of the Silicon Valley'

Funding campus: **Private**: Stanford University

Vision campus: V4-Motto: Great ideas growth here.

Controllers campus: **Defined**: Stanford Real Estate

By Jrissman (Own work) (CC BY 3.0) via Wikimedia Commons

financial | strategic

physical | functional

Population campus: **23.000**
(P1-Employees: 23.000) *1990s

Orgs. in campus: **151**
O1:150 companies
O2: 2 offices, 1 School; 1 Library; a Medical Centre and Hospital of Stanford University.

Facilities in campus:
F1: Restaurants, Cafes
F2: University Club; Sport facilities
F3: Hospital, Medical Centre

F1
F2
F3

Scale campus: **M** (Area in a District)

Land use area: **283 ha**

Density city: **1.041** inh./sq km (*USCB, 2010) *converted

Transportation City: Bus, Caltrain and Bike

Population city: **66.363** (USCB, 2012, est.)

Employment city: **98.000**
Main employers-staff: Stanford University

Tertiary education city: **1** university (Stanford University, R-2)

Distance campus to:

Airport	City centre	University
32 km	**4,9 km**	**4,1 km**
90'	**30'**	**10'**
San Jose Airport	Palo Alto Caltrain Station	Stanford University

Amenities city:
A1: 5 branch libraries, 4 museums
A2: 3 shopping centers; downtown shopping district; >100 restaurants in downtown; 1 amusement park
A3: Several parks; 3 Golf Courses;

A1
A2
A3

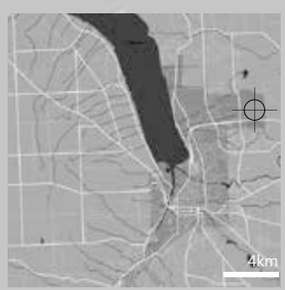
Touches

Cornell Business & Technology park

Ithaca, New York, USA

Code: **2-CBTP**

Year: **1952**



Official denomination:

Permanent: Business & Technology Park

The Cornell Business & Technology Park is a suburban office and lab park, regarded as a place that provides a first class environment for local, national and international office and research firms. The park provides an interface between Cornell University and the business community. A majority of the companies within the park are technology-based, many of which conduct research associated with or derived from Cornell University. (Based: Cornell Real Estate)

Cluster base campus:

R&D: 62% of the companies are technology-based, many of which conduct research associated with or derived from Cornell University.

Economic base city:

Consolidated: shipping port, agriculture, dairy farming, and business machine manufacturing

Emergent: High-technology firms, biotechnology, and electronics. The research activity at Cornell University is largely responsible for this expansion of 'clean' industries. Education and Touristm also contribute to the economy.

Vision city: V3-Concepts: 'Diversity & Sustainability'
V4-Motto: Ithaca a Model Community: A great place to create, dream, live, learn, work and play.

Vision campus: V1-Ambition: Keeping Ithaca a great place to live, by helping companies provide quality jobs, tax revenues, and strengthen the community's economic base.

Google Earth, 2016

functional | physical

Population campus: **2.000**
P1-Employees: 2.000

Orgs. in campus: **81** est.
O1: 80 companies
O2: 4 offices of Cornell University.

Facilities in campus:
F1
F2
F3

F1:Cafes & Restaurants
F2: exercise facility, picnic area, waterway
F3: Marriott Courtyard Hotel, child-care center, medical clinics
F-Other: Airport, Post Office.

Population city: **30.331** (USCB, 2012, est.)

Employement city: **14.863** employed
Main employers-sector: Educational services, and health care and social assistance industry

3rd education city: **1** university (Cornell University, R- 20)
HEI: 1 (Ithaca College)

Amenities city:
A1
A2
A3

A1: 7 theatres; 8 museums and science centres
A2: Downtown Ithaca Commons pedestrian mall, several restaurants, Farmers market
A3: Several waterfalls and State Parks

Ext. Promoters: Prom2: the City of Ithaca play a role as promoter in branding and marketing for business location.

Funding campus: **Private**: Cornell University and the General Electric Company. When GE announces it is leaving Research Park, Cornell appropriates capital to further the development of the Park, contingent on matching funds from the community. Tompkins County Area Development (TCAD) Corporation assumes primary role of development of the Park.

Controllers campus: **Defined**: Cornell University Real Estate Department.

strategic | financial

Scale campus: **M** (Area in a District)

Land use area: **121 ha**

Density city: **2.151** inh./sq km (*USCB, 2010) *converted

Transportation City: Bus TCAT system (Tompkins Consolidated Area Transit bus trasport system); Bike

Distance campus from:

Airport	City centre	University
0,8 km	9,6 km	7,5 km
<5'	15'	10'
Ithaca Tompkins Regional Airport	Downtown Ithaca	Cornell University

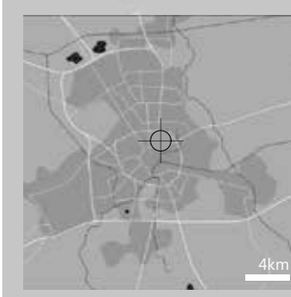
TU/e Science Park

Eindhoven, North Brabant, NL

Contains

Code: **3-TUESP**

Year: **1957**



Ext. promoters: Prom1: The Municipality of Eindhoven helps to draw the development vision together with the university; Brabant Development Agency (BOM); The City Region Eindhoven (SRE).
Prom2: Brainport Foundation and Brainport Development. The latter is a agency of the Brainport foundation represented by members of the triple-helix, including the university, which task is to drive the region forward and make the economy of the region 'future proof'.

Funding campus:
Private changed from Public: Eindhoven University of Technology, originally public funded until 1995 when ownership of the campuses was ransferred from the Dutch government to the institutions.

Vision city: V1-Strategy: Brainport 2020
V2-Ambition: to develop the Eindhoven region as an internationally recognised technology region; to position the Southeast Netherlands as a leader in the international knowledge economy.
V3-Concept/Pillars: People; Technology; Business; Basics; Governance ; and international cooperation.V4-Motto: Top Economy, Smart Society / V4-Slogan City: 'Leading in Technology' (Eindhoven City Region).

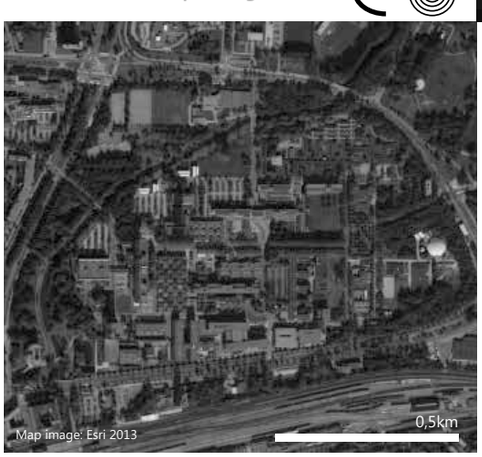
Vision campus:
V1-Plan: From university Campus to Science Park, Masterplan TU/e Science park 2010 - 2020
V3-Concept:The campus will become a 'Living Lab': a laboratory in which researchers and students cooperate with industry to put tomorrow's solutions into practice.
V4-Motto: 'Where innovation starts'

Controllers campus: **Defined**: Eindhoven University of Technology Real Estate Management

By Stephane Gaudry from Best, Netherlands (CC BY 2.0) via Wikimedia Commons

Official denomination:
Changed: from University Campus to Science Park

financial | strategic



physical | functional

Population campus: **12.361**
P1-Employees: 3.131 including 1.900 academic staff
P2-Students: 9.230 including 4.740 BSc students; 3,070 MSc students; 260 PDEng; 1.160 PhD

Orgs. in campus: **37** aprox.
O1:30 start-up companies aprox.
O2: 9 departments of TU/e;1 HEI-Fontys University of Applied Sciences
O3: 5 research institutes.

Facilities in campus:
F1: conference centres; shops
F2: sport facilities; cultural centre; park and water corps
F3: Student housing

Located at the hearth of the city, TU/e has consulted closely with the municipality of Eindhoven to draw up a development vision for the campus and ascribe it with a more appropriate name: TU/e Science Park. TU/e Science Park will be an attractive place for students, researchers and entrepreneurs to meet, with excellent facilities and amenities. (Source: presentation TU/e Website)

Scale campus: **S** (Portfolio in an Area)

Land use area: **70,4 ha** (75 ha including 2 plots around)

Density city: **2.499** inh./sq km (2011)

Transportation City: Interlocal Bus lines, National railway network,bike infrastructure, the 'Phileas'; a regional bus rapid transit; served by Eindhoven Airport

Distance campus to:

9 km	1 km	≤1 km
100'	10'	≤15'
Eindhoven Airport	Eindhoven Central Station	TU/e
Airport	City centre	University

Population city: **219.173** (CBS, 2013)

Employment city: **>145.000** (2009)
Main employer-sector: Consultancy, Research and Specialised services

Tertiary education city: **1** university (Technology University of Eindhoven,R-115)
HEI: 2 (Fontys Fontys University of Applied Sciences and the Design Academy)

Amenities city:
A1: 4 large museums and serveral smaller museums; 1 international school; big public library
A2: shopping centre 'De Heuvel Galerie', amusement park 'Efteling'
A3: Genneper Parks, Stadswandelpark, Dommeldal and the wood at Strijp

Cluster base campus:
SciResearch+R&D: Energy, Health and Smart Mobility.

Economic base city:
Consolidated: high-tech industrial clusters include mechatronics, the automotive industry and electronics.
Emergent: industrial distribution, environmental technology, medical technology and information technology.

Akademgorodok Academic Town

Novosibirsk, Siberia, RU

Equals

Code: **4-AAT**

Year: **1957**

Official denomination:

Permanent: Academic Town

Akademgorodok, ('Academic Town' in Russian) is a scientific research city located near Novosibirsk at the northeast corner of the Novosibirsk Reservoir, south-central Russia. Akademgorodok is home to numerous research institutes and is the seat of the Siberian Branch of the Russian Academy of Sciences. It is, with Moscow and St. Petersburg, an important research and educational centre in Russia. Nowadays Akademgorodok houses Academpark; an integrated technology park with unique business and technological infrastructure providing ideal conditions for the generation and the development of innovative companies as well as the development of existing innovative productions; it is regarded as a place where research turns into industrial technologies.

Cluster base campus:
R&D: technologic development in microelectronics and nanoelectronics, ray and laser technologies, catalysis technologies, advanced materials, information technologies, and biotechnologies.

Economic base city:
Consolidated: Novosibirsk's economy is based on industries (aircraft, nuclear, engineering, power, metal working, and pharmaceutics), trade, services, transport, construction, science, and scientific services.

Vision city: V2-Ambition: Sustainable improvement in the quality of life of the general population of Novosibirsk; in the welfare of the inhabitants; in the economic growth potential.
V3-Concept: Strategic Sustainable Development (Translated Novosibirsk, 2004)

Vision campus: V2-Ambition:Conceived as a milieu of scientific innovation to serve the industrial development of Siberia and the Sovietic Union.

By Elya (GFDL or CC-BY-SA-3.0) via Wikimedia Commons

functional | physical

Population campus: **70.000**
(Residents: 70.000) *1990s

Orgs. in campus: **256** aprox.
O1: 220 companies
O2: Novosibirsk State University
O3:>35 research organs of the Siberian Branch of Russian Academy of Sciences.

Facilities in campus: F1: Shopping centre, cinema, bars, supermarkets, billiard and night clubs
F2: saunas, sport grounds; Botanical garden
F3: residential areas

F1
F2
F3

Population city: **1.400.000** (Census 2010)

Employement city: **750.000** (in Novosibirsk)

3rd education city: **14** universities in Novosibirsk
HEI: 7 academies, and 15 institutes including 12 branches of higher education institutions based in other cities.

Amenities city: A1: 15 theatres
A2:the Novosibirsk Zoo,Planetarium Children's and Youth Centre

A1
A2
A3

Ext. Promoters: Prom2:The Administration of Novosibirsk region addresses AAT as Novosibirsk Scientific Center (NSC) and promotes it as a pillar in the presentation of the region.

Funding campus: **PPP-Changed from Public** Akademgorodok started as scientists dream supported by the socialist government planning in the 60s. After the transition to a market economy in the 90s, the Administration of Novosibirsk region together with the management of the Siberian branches of the Russian Academies of Sciences carried out a range of works on the establishment of a Scientific and Technological Park (Technopark) 'Novosibirsk' in this territory of the region.

Controllers campus: **Undefined**: Akademgorodok Academic Town is part of the Municipality of Novosibirsk. The Siberian branches of the Russian Academies of Sciences addresses Novosibirsk and AAT as the central location of the Siberian Branch. Nowadays, large projects in AAT that involve urban area development are beign presented by the Siberian Branch of the Russian Academies of Sciences.

strategic | financial

Map image: Esri 2013

Scale campus: **L** (District or Town)

Land use area: Not found

Density city: **2.833,4** inh./sq km

Transportation City: Trans-Siberian Railway, 4 railway stations, buses, trolleybuses, trams, taxicabs, shuttle taxicabs and a subway

Distance campus from:

44 km	28 km	≤1 km
120'	70'	≤15'
Tolmachevo Airport	Novosibirsk-Glavny Station	Novosibirsk State University
Airport	City centre	University

Research Campus Garching - Technical University of Munich

Garching, Munich Metropolitan Region (EMM), DE

Disjoints

Code: **5-RCG-TUM**

Year: **1957**

Official denomination:

Permanent: Campus

Ext. promoters: Prom1:Municipality of Garching promotes higher education and research at TUM as a pilar for the economic development of the region as a business location. Also, developing and planning infrastructure (e.g.The design of the B11 in 2012, the construction of office buildings and research that should be available at the TU Munich)

Funding campus: **Public & Private**: The state has invested around 1,3 billion euros in the TUM's Garching infrastructure since 1995. The Budget of the university comes from these sources: study fees; state subsidies; Third Party Funding; and own income (e.g. research, medical care, materials testing). In 2007-2008 a pan-European investor competition was conducted and the grouping of several medium-sized Bavarian company won - the first PPP project at Bavarian universities.

Controllers campus: **Defined**: Real Estate Management Department at TUM Central Administration

Vision city: V2-Ambition Region: to increase the attractiveness of the entire economic space in the greater Munich. It focuses on four areas of action: knowledge; economy; mobility; and Environment & Health. (Munich Metropolitan Region Inititative - EMM)
V2-Concept Garching: Science and research as a business location is a key driver and evolving the brand of Garching./
V4-Slogan Garching: 'City will be city, town remain!'

Vision campus:
V2-Ambition: new ways toward a competitive university of international standing (2006 Excellence Initiative)
V4-Motto:'TUM. The Entrepreneurial University' (Institutional Strategy)

By Graf-flugplatz (Own work) (CC BY-SA 3.0) via Wikimedia Commons

financial | strategic

Scale campus: **S** (Portfolio in an Area)

Land use area: **170 ha**

Density city: **4.440** inh./sq km (Munich EMM)
576 inh./sq km (Garching)

Transportation City: European Railway network - ICE high-speed trains; Underground railways and suburban trains; Tramway / Regional buses, Underground railways; Taxi (Munich EMM / Garching)

Distance campus to:

Airport	City centre	University
17 km	**23 km**	**≤1 km**
23'	**57'**	**≤15'**
Munich Airport	Munich Hauptbahnhof	Technical University of Munich

physical | functional

Population campus: **15.000**
P1- Employees: 5.000
P2- Students: 10.000

Orgs. in campus: **15** aprox.
O1: 7 companies
O2: 4 departments and 1 faculty of TUM
O3: 7 research institutes

Facilities in campus:
F1
F2
F3

F1: restaurants, cafes
F3: kindergarden
F-Plan: Recreational facilities, an integrated shopping mall and various restaurants (2007)

Population city: **5.500.500** (Munich EMM)
16.901* (*Garching, 2012)

Employment city: **2.100.000** (Munich EMM, 2010)
Main employers-sector: Education and teaching 22,2%; Business services 18,6%; Information Technologies 16,4%.

Tertiary education city: **15** universities in Munich (2 in Garching including Technical University of Munich, R-88; and a research site of the Ludwig-Maximilians-University of Munich, R-45)

Amenities city:
A1
A2
A3

A1: 452 museums, 165 theaters, 15 monuments / City library, 1 theatre
A3: 4 national parks; 7 winter sport areas; 89 pools / Garden park and lake; sport area (Munich EMM / Garching)

The Garching Campus has developed in the north of Munich from the Neutron Research Facility (1957) as a science and engineering campus. The concentration of scientific and technical research institutions and companies work in areas ranging from basic research to the development of high-tech applications.

Cluster base campus:
SciResearch+R&D: fields of TUM faculties are chemistry, mechanical engineering, computer science, mathematics and physics. Research institutes specialise in areas such as Medical Technology, Semiconductor Physics and Catalysis.

Economic base city:
Consolidated: Innovative and future-oriented high-tech industries (aerospace and electronics, vehicle and machine construction), service sector (media, banking and insurance trades) /office location and service production
Emergent: information and communication sector / research and development. (Munich Metropolitan Region / Garching)

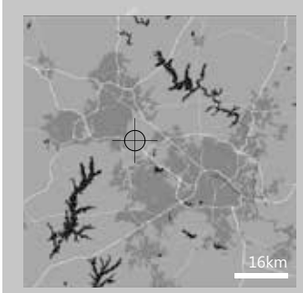
Disjoints

Research Triangle Park

The 'Triangle region' between Durham, Raleigh, and Chapel Hill, North Carolina, USA

Code: **6-RTP**

Year: **1959**



Official denomination:

Permanent: Park

Leaders in business, government and academia together framed an ambitious plan to transform thousands of acres of woods and farmland into one of the world's first science parks. The fruit of this vision, the Research Triangle Park (RTP), has been a resounding success, leading the way in creating a more diverse, knowledgebased economy and generating considerable prosperity in the region and in the State of North Carolina as a whole. (Source: RTP Master Plam, Research Triangle Foundation of North Carolina, 2011)

Cluster base campus:

R&D: Biotechnology & life sciences, clean & green energy, advanced gaming & e-learning, information technology.

Economic base city:

Key industries: Technology, Life Sciences; and Cleantech.

Vision city: V1-Strategy: Regional economic-development strategy 2009-2014
V4-Motto region: 'The Shape of Things To Come'
V4-Slogan region: 'Work in the Triangle, smarter from any angle'

Vision campus: V1-Plan: The Research Triangle Park Masterplan, November 2011
V3-Concepts/Pillars: Employment, Innovation and Sustainability
V4-Motto: the future of great ideas.

By RTI International (CC BY-SA 3.0) via Wikimedia Commons

functional | physical

Population campus: **38.000**
P1-Employees: 38.000

Orgs. in campus: **173** est.
O1:170 companies
O2:TUCASI campus -Triangle Universities Center for Advanced Studies Inc. is the home of the three Founding Universities (Duke University, NC State University, and UNC-Chapel Hill)

Facilities in campus:
F1
F2
F3
F2: Park and natural area
F3: Hotel
F-Plan: Cafes and other retail uses, active open space, shared business support services and shared conference facilities.

Population city: **761.244** (UCSB 2012, est.*)
*Data combined Durham, Raleigh, and Chapel Hill

Employement city: **362.578** (*Data combined Durham, Raleigh, and Chapel Hill, 2011)
Main employers-sector: technology industry accounts for nearly 50,000 jobs

3rd education city: **5** universities (including Duke University, R-22, North Carolina State University, University of North Carolina at Chapel Hill, R-43)

Amenities city:
A1
A2
A3
A1:>20 museums
A2: >15 shopping malls
A3:several parks
(in the Triangle region)

Ext. Promoters: Prom1: The Research Triangle Region actively promotes RTP as main place to work under the flagships 'Work in the Triangle, smarter from any angle' Research Triangle Regional Partnership (RTRP) is a business-driven, public-private partnership dedicated to keeping the 13-county Research Triangle Region economically competitive through business, government and educational collaboration.

Funding campus:
PPP: The Research Triangle Foundation of North Carolina. State and local governments teamed up with the universities and local business to construct RTP. The existing land use is 16% RTP Foundation (For sale sites, headquarters, and Natural Area Preserve); 13% roadways; 71% leaseholders and research companies

Controllers campus:
Defined: The Research Triangle Foundation of North Carolina manages the sites and expansion services in campus.

strategic | financial

Scale campus: **L** (District or Town)

Land use area: **2830 ha**

Density city: **833** inh./sq km aprox. (*Data combined Durham, Raleigh, and Chapel Hill, USCB, 2010)

Transportation City: Triangle Transit (City Bus Service, Regional Bus Service); Nationwide Bus Service; Taxi; Ridesharing Services; Raleigh–Durham International Airport)

Distance campus from:

11 km	13,5 km	3 km
40'	50'	5'
Raleigh Durham International Airport	Durham Station	TUCASI campus (3 universities in campus)
Airport	City centre	University

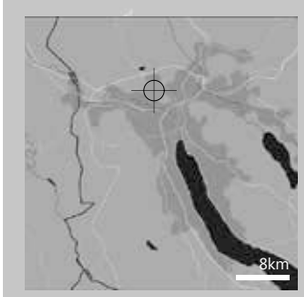
ETH Hönggerberg Science City

Zürich, Zürich CH

Touches

Code: **7-ETHSC**

Year: **1959**



Ext. promoters: Prom2:The current vision of the City of Zurich '2000-Watt Society' was developed at the Swiss Federal Institute of Technology (ETH). In the Education and Knowledge portrait of the city, ETH is presented as the flagship of Swiss college. In the history of the City, the universitoes -including ETH- and cultural bodies areaddressed as a pillars in Zürich as an economic, scientific and cultural centre.

Funding campus:

Private & Public: ETH operates with 75% Government funds and 25% Third-party funds (2012). 'Realizing the Vision Together': The numerous architectural projects on site could only be realized with the help of generous sponsors. Also in the future ETH Zurich will rely on strong partners from the economy as well as private donors, in order to provide an optimal environment and to maintain its international reputation as a leading technical school.

Controllers campus:

Defined: the Vice President of Human Resources and Infrastructure is responsible for the management of construction projects including the corresponding relations to the public and political authorities as well as the management of the real estate portfolio. ETH Zurich Property develops and implement a real estate strategy.

Vision city: V1-Policy: '2000-Watt Society' developed at ETH is a model for energy policy which demonstrates how it is possible to consume only as much energy as worldwide energy reserves permit and which is justifiable in terms of the impact on the environment.

Vision campus: V1-Strategy: ETH strategic orientation 2012-2016 and Real Estate Strategy 2008-2011/2015 approved by the Board of ETH Zurich.
V2-Ambition: Achieving Sustainability: by 2025, the campus can be largely CO2-free.
V3-Concept: Culture of empowerment, making space for creativity and supporting innovative ideas. A dominant theme is the idea of networking on all levels. ETH strategy for 2012-2016: sustainable growth as the guiding theme
V4-Motto Institution: 'Where the Future begins' V4-Motto campus: 'City district for thinking culture'

By GurkanSengun (Public domain) via Wikimedia Commons

Official denomination:

Changed: from Campus to Science City (2013)

financial | strategic

Scale campus: **S** (Portfolio in an Area)

Land use area: **32 ha**

Density city: **4.289** inh./sq km (2011)

Transportation City: Trams, buses, ferries, suburb trains and funiculars; international rail links including high-speed trains; Zürich airport

Distance campus to:

14 km	6 km	≤1 km
20'	26'	≤15'
Zürich Airport, Kloten	Zürich Hauptbahnhof	ETH Zürich
Airport	City centre	University

physical | functional

Population campus: **8.800**

P1-Employees: 3500
P2-Students :5300 (*2007)

Orgs. in campus: **11** aprox.

O1:10 companies planned (*2007)
O2:7 ETH departments

Facilities in campus:

F1: Mobile cafes and food, market, central auditorium
F2: sports, 365.000 m2 of green space, 4 gardens
F-Plan: The university intends to build a total of 900 rooms for students on the campus by 2015.

Population city: **376.990** (2011)

Employment city: **362.012** (2008)
Main employers-sector: 90% of employed are in the service sector.

Tertiary education city: **2** universities (ETH Zürich, R-15; the University of Zürich, R-61)
HEI:3 (The Pedagogical College, the Zürich University of Applied Sciences and the Zürich University of the Arts)

Amenities city:

A1:>50 museums, >100 galleries, Opera House, several architecture attractions and heritage sites
A2: >135 stores in city, shop district street; several international restaurants
A3: natural park , public gardens, mountain, lake and rivers for hiking activities, adventure parks and zoo.

Hönggerberg campus is located on the outskirts of the city of Zurich. It is presented by the university as 'a perfect example of the links between science, industry and the general public'. The ETH intends in the coming years for its location on the Hoenggerberg to develop its education and research facilities as well as continue to create a dynamic city quarter with an attractive environment in which people live and interact.(Source Science City official website)

Cluster base campus:

SciResearch: main areas are Sustainable worlds; Technology and knowledge for health; Complex systems; Materials, Technologies and industrial processes; Scientific foundations of the future.

Economic base city:

Consolidated: The finance sector generates around a third of the wealth and a quarter of the jobs in the city. Various innovative businesses and industries.
Emergent: Biotechnology, life sciences (currently enriching the medical tech sector) the automotive supplier industry, aerospace and the creative economy.

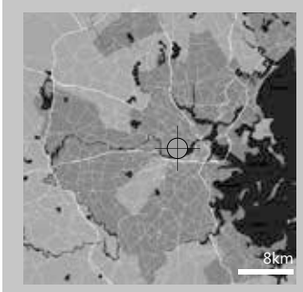
Overlaps

MIT Campus & University Park at MIT

Cambridge, Massachusetts, USA

Code: **8-MIT - UP**

Year: **1960** (*Masterplan)



Official denomination:

Permanent: Campus. (New developed areas have distinct names)

Located in Cambridge since 1916, this campus accommodates a private university: the MIT. This campus had a significant period of expansion and change after WWII. In 1949, a review of MIT's organization and misson called for the development of a new campus plan. In 1960, a Campus Master Plan established the ground rules for the campus future development. This plan has been reviewed, amended and improved every five years, but its basic goals have served as the standards for physical decisions regarding the evolution of MIT's campus (Simha, 2001). In 1983 MIT developed in partnership with Forest City, University Park at MIT: a 11 ha development located directly adjacent to the MIT Campus. The project successfully integrates scientific research facilities with more than 670 residential units, a hotel and conference center, retail amenities, and more.

Cluster base campus:
SciResearch: Fields of study at MIT include architecture; engineering; management; science; humanities, arts, and social sciences **+ R&D:** Biotechnolgy companies settled at UP.

Economic base city:
Consolidated: life-sciences and technology business.

Vision city: V2-Ambition: The City of Cambridge is dedicated to maintain its competitiveness and desirability as the place to live, work, and do business
V4-Slogan: Cambridge - the heart of innovation!

Vision campus: V1-Plan: MIT 2030 is a living framework that guides our planning activities, with a focus on fulfilling the MIT mission and keeping the innovation engine running well into the 21st century.
V3-Concepts: Innovation and collaboration; Renovation and renewal; Sustainability; Enhancement of life and learning
V4-Motto University: 'Mind and Hand'
V4-Slogan MIT 2030 framework: Envisioning, Renewing and Building for the future.

By DrKenneth (Own work) (CC BY 3.0) via Wikimedia Commons

functional | physical

Population campus: **26.489** aprox.

P1-Employees: 11.000 MIT staff including Faculty (1.753)
P2-Students: 11.189
Others-University Park: 3500 employees and 800 residents

Orgs. in campus: **16**

O1:No companies in campus property due to MIT's tax-exemption status / 15 companies in University park
O2: 5 schools; 56 Interdisciplinary Centers, Labs, & Programs of MIT.

Facilities in campus:

F1: museum and art centre, cafes, library / retail
F2: 10,5 ha of playing fields / parks and open space with public art
F3: 19 students residences / residential area, 668 rental apartments and MIT graduate students dormitories (MIT campus / University Park)

Population city: **106.471** (USCB, 2012, est.)

Employement city: **59.018** (USCB, 2011)
Main employers-sector: biotechnology companies with 8.000 workers;
Main employers-staff: Harvard University and MIT

3rd education city: **2** universities (Harvard University, R-2; Massachusetts Institute of Technology, R-7)
HEI: 2 (Lesley College and Cambridge College)

Amenities city:

A1: Main Library and 6 branches; 6 museums
A2: 7 commercial districts (retails, hotels, restaurants and shops)
A3: 1 Golf Course; 80 Parks, Playgrounds and Reservations;

Ext. Promoters: Prom2: The City of Cambridge, presents MIT as an institution with a large impact on the economy of the region. The Institute is Cambridge's second largest employer and largest taxpayer; and The Cambridge Community Development Department (CDD) is developing important areas (University Park inLower Cambridgeport and Kendall Square in east cambridge) that serve the MIT community.

Funding campus: **Private:** MIT Corporation (board of trustees). MIT is a coeducational, privately endowed research university. With a campus located between Central and Kendall Squares, and across the Charles River from Boston, the Institute has an optimal position to engage in collaborative endeavors with its neighbors and give back to the community.

Controllers campus: **Defined:** MIT Investment Management Company (MITIMCo) in two teams: The Investment team supports MITIMCo's mission by sourcing, executing and managing investments in accordance with their Investment Principles (incl. Rea Estate team); The Operations team supports MITIMCo's mission by managing MIT's financial resources. MIT Department of Facilities (Campus Planning, Engineering, and Construction (CPEC)) works with the Office of the Vice President for Finance, MITIMCo and other stakeholders to identify the Institute's current academic priorities and development goals. When a top priority emerges, a working group of key stakeholders charged by the Committee for the Review of Space Planning (CRSP)

strategic | financial

Scale campus: **M** (Area in a District)

Land use area: **67,9 ha**

Density city: **6.361** inh./sq km (*USCB, 2010)

Transportation City: Two subway lines with 6 stations and one commuter rail station; 29 bus routes through Cambridge that connect to Boston MA; EZ Ride Shuttle; network of pedestrian walkways and bikeways. Served by Logan International Airport in Boston

Distance campus from:

8 km	1,4 km	≤1 km
40'	<15'	≤15'
Logan International Airport	Cambridge Central Square	MIT
Airport	City centre	University

Drienerlo Campus University of Twente & Kennispark Twente

Enschede, Overijssel, N

Touches

Code: **9-DCUT**

Year: **1961**

Official denomination:

In transition: from Campus to Park

Ext. promoters: Prom1:The Foundation Kennispark Twente is a joint initiative of the University of Twente, the City of Enschede, the Region of Twente, the Province of Overijssel and the Saxion University of Applied Sciences.

Funding campus:

PPP in transition from Private (Originally Public): Foundation Kennispark Twente is a joint initiative of the University of Twente, the City of Enschede, the Region of Twente, the Province of Overijssel and the Saxion University of Applied Sciences. The University of Twente and the city of Enschede have partnered up to make sure the area becomes and stays a state of the art innovation campus and have initiated several projects. The University of Twente and its campus was originally public-funded until 1995 when ownership of the campuses was ransferred from the Dutch government to the institutions.

Controllers campus:

Defined (in transition): Since 1995 the university became owner of Drienerlo campus. In 2013,, the university has a campus management section called The Eenheid Campus which consist of the Booking office, Event office, Vrijhof Culturecentre and the Sports centre. The University of Twente and the city of Enschede have partnered up to make sure the area becomes and stays a state of the art innovation campus.

Vision city: V1-Strategy: Development Vision Network City Twente 2040, June 2013
V3-Concept/ Pillars: the urban quality; collaboration and respect for complementary diversity.
V4-Slogan: Enschede, where the sky's the limit.

Vision campus:

V1-Plan: Kennispark Area Development Masterplan
V2-Ambition: to create an attractive business climate. Through Kennispark Twente the Foundation Kennispark Twente share the economic development goal of creating 10.000 new jobs for the region.
V4-Motto campus: Empowering Innovation & Entrepreneurship
V4-Motto Institution: High Tech, Human Touch

By Daiancita (Own work) (CC BY-SA 3.0) via Wikimedia Commons

financial | strategic

Scale campus: **M** (Area in a District)

Land use area: **180 ha** aprox.

Density city: **1.122** inh./sq km

Transportation City: National railway network, Interlocal Bus lines; served by Enschede Airport Twente; Bike infrastructure

Distance campus to:

Münster Osnabrück International Airport	Enschede Central Station	University of Twente
92 km	4,1 km	≤1 km
160'	20'	≤15'
Airport	City centre	University

physical | functional

Population campus: **19.690** est.

P1-Employees: 6.300 commercial jobs, 3.000 scientific positions and 2.630 staff from University of Twente
P2-Students: 7.760

Orgs. in campus: **381**

O1: 380 companies
O2: 6 faculties of the University of Twente

Facilities in campus:

F1: F1:conference centres; film and music studios; stages
F2: F2:sport facilities
F3: F3: Student housing and hotels

Population city: **158.194** (CBS, 2013, est.)

Employment city: **80.742** (active staff, 2011)
Main employers-sector: 19% in Health care & Welfare; 16% Business

Tertiary education city: **1** university (University of Twente, R-200)
HEI: 1 (Saxion Hogeschool)

Amenities city:

A1: A1:2 Museums, >5 Theatres and concert halls, several restaurants and pubs.
A2: A2: 1 shopping centre and 350 shops
A3: A3: 1 football stadium; several parks.

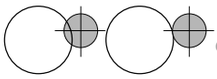
Drienerlo Campus is the campus of the University of Twente located between the cities of Hengelo and Enschede. The innovation Campus Kennispark Twente integrates in an area the Campus of the University of Twente and the Business and Science Park.

Cluster base campus:

R&D: ICT, biotechnology and nanotechnology

Economic base city:

Key industries: Twente is specialist in High Tech Systems (nanotechnology; mechatronics; sensing, monitoring and imaging; semiconductors; industrial printing; hightech engineering) and Materials.

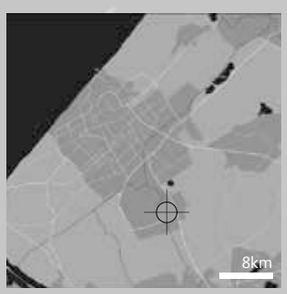


TU Delft District & Technopolis and Innovation Campus Delft

Delft, South Holland, NL

Code: **10-TUDTIC**

Year: **1961-65**



Official denomination:

In transition: from TU-District (TU-Wijk in Dutch) to Innovation Campus (in TIC Masterplan)

Firtsly established in the inner city, TU Delft gradually moved to the Wippolder, a district in the South of Delft. In the period of 1961 to 1965 a large number of buildings were located in the Wippolder (Baudet, H, p430) Currently, the campus has three main areas: North, Centre and South with different characteristics and strategies. The south will become Science Port Holland, developed between the municipalities of Delft and Rotterdam, adding large related business and stimulating university-industry interaction. (Den Heijer, 2011) The Technopolis and Innovation Campus Delft (TIC-Delft)currently on planning phase, cover the area where TU-Delft District is located

Cluster base campus:

SciResearch: Health & Lifesciences; Cleantech; Infrastructures & Water; High Tech Systems & Materials Creative Industry

R&D: Ambition for TIC is focused on Water and Delta technology; ICT, industrial biotechnology, and health and life sciences; and smaller concentrations of organisations active in nanotechnology, aerospace, industrial design and architecture.

Economic base city:

Key sectors: The region South-Holland focuses on two themes: medical technologies and clean technology aligned with both the Dutch agenda on science and innovation policy, the 'top sectors' initiative, and the European research agenda Horizon 2020.

Vision city: V1- Strategy Region: Zuid-Holland Structural Vision 2020 /V1-Strategy City: Delft City of Knowledge Strategy since early 90s
V2-Goals: strengthening of specific sectors and promoting entrepreneurship. /V2-Goal Region: Rotterdam, Delft and Leiden have the ambition to be in the top 3 of knowledge and innovation regions of Europe by the year 2025.
V4- Brand City: 'Delft, City of Innovation'

Vision campus:

V1-Plan: Campus vision 2030
V2-Goals:to make the campus an integrated part of the city of Delft by increasing density – of floor area and people – and allowing other and related functions on the large campus /V2-Ambition TIC-Delft: Linked to the expertise of TU Delft, the area will be developed into an engine for R&D activities and High Tech production.
V4-Motto University: 'Challenge the future' / Slogan TIC-Delft: 'Driving force of the Randstad knowledge Economy'

By M8scho (Own work) (CC BY-SA 4.0) via Wikimedia Commons

Ext. Promoters: Prom1:The Municipality of Delft, is actively involved with the university in the development of a masterplan for the TIC-Delft. / The Province of Ziud Holland outline TUDelft Campus and TIC-delft as a cluster of knowledge intensive activity of a so-called knowledge axis in the region. The province authorities aim to develop this axis since they are of economic importance for the region.

Funding campus:

Private changed from public: TU Delft was publicly funded by the Dutch government until 1995 when the ownership of the campus was transferred to the institution. Nowadays, TU Delft owns and manages its building complexes and land. Large-scale projects often require the involvement of external parties. Real Estate Development maintains contacts with e.g. the municipality of Delft, 'Stadsgewest Haaglanden' (Haaglanden Regional Authority), DUWO, TNO, private developers, The Hague University of Professional Education, INHOLLAND University and other university real estate organisations.

Controllers campus:

Defined: TU Delft Real Estate Development is responsible for the development and realisation of the TU-wide real estate strategy. The activities of Real Estate Development include the initiation, definition and coordination of real estate investment projects, controlling and directing the internal and external use of space in the buildings, the preparation of real estate transactions (purchase, sale and leasehold) and the strategic developments that reach beyond the campus.

functional | physical

Population campus: **22.860**

P1-Employees: 5.330 TUD staff including 3.070 academic (* 2011 in den Heijer)
P2-Students: 17.530

Orgs. in campus: **39** aprox.

O1: 19 TU Delft Enterprises; >15 star-ups
O2: 8 Faculties and 26 research institutes of Delft University of Technology; 2 HEIs
O3: 2 independent Research Insitutes (Deltares & TNO)

Facilities in campus:

F1
F2
F3

F1: cultural centres; restaurants; library; central auditorium
F2: sport centre and sport fields; central park
F3:Student housing
F-Plan: shops and commerce

Population city: **98.727** (CBS, 2013)

Employement city: **45.685** (2008)
16.531 employed are knowledge workers (36,1%) (Gemeente Delft, 2010)

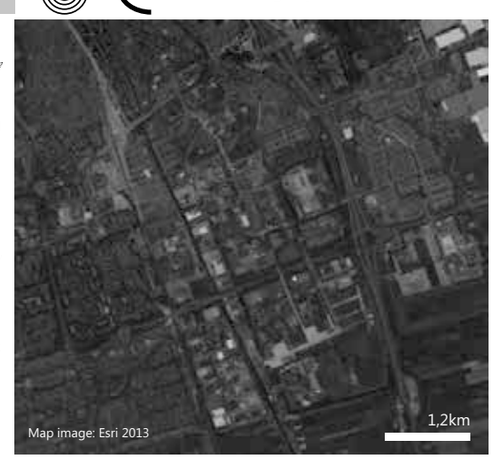
3rd education city: **1** university (Delft University of Technology, R-104)
HEI:2 (InHolland and De Haagse Hogeschool)

Amenities city:

A1
A2
A3

A1: 13 Museums, 23 art galleries and ateliers; souvenirs shops; historic monuments and architecture; several event and festivals; 1 library; 2 cinemas, 1 theater
A2: 65 cafes and pubs; 121 restaurants and bars serving meals
A3: 2 sport halls; 2 swimming pools; lake and woods.

strategic | financial



Scale campus: **M** (Area in a District)

Land use area: **162 ha** (500 ha TIC-Delft Masterplan)

Density city: **4.326** inh./sq km (2011)

Transportation City: National railway network, Interlocal bus and tram lines; Delft is served by Rotterdam-The Hague Airport and Schiphol Airport; bycicle infrastructure.

Distance campus from:

Airport	City centre	University
48 km	2,5 km	≤1 km
60'	<15'	≤15'
Schiphol Airport	Delft Station	Delft University of Technology

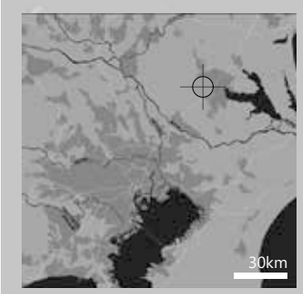
Tsukuba Science City

Tsukuba, Ibaraki, JP

Equals

Code: **11-TSC**

Year: **1968**



Ext. promoters: Prom1:'Tsukuba Global Innovation Promotion Agency' has been established as a central unit of academic-industrial cooperative system which mainly promotes business in International Strategic Zone. Tsukuba Science City Network (TSCN) with 103 members, works on research exchange and other common issues, to keep the vision of the city as stated in the Third Science & Technology Basic Plan.

Funding campus:

PPP in transition from Public TSC was a national research centre, funded totally by government. Nowadays, a new industry-government-academia collaboration system is to be constructed to change Tsukuba by using a preferential legal and tax measures that are available in the zone. The government bought land only for public facilities. A Land Readjustment Program witholds land for public insfrastructure such as parks and roads, and redistributes the land in proportion to the original land holding.Tsukuba involved 10 coperative groups with over 3000 land owners (Nishimaki, 2001)

Controllers campus:

Defined: As International Strategic Zone Tsukuba is managed by the Planning Department, Science and Technology Promotion Division.

Vision city: V1-Policy:Tsukuba is designated as International Strategic Zone in Japan. The ISZs commit to industrial promotion given advantage on regulatory standard requirements and financial help from governmental body and local autonomy.
V4-Motto City: 'Innovate today to create the future'

Vision campus: V1-Policy: 'Comprehensive Special Zone for International Competitiveness Development' is a system aiming to form an integrated base for industry and function which can be an engine of Japan's economic development. It comprehensively enforces the special regulatory measures and tax, fiscal and financial support measures regarding regional comprehensive and strategic effort.
V4-Motto Campus: 'Innovate today to create the future'

By On-chan (Own work) (CC BY-SA 3.0) via Wikimedia Commons

Official denomination:

Changed from Town (Tsukuba Creation Act) to International Strategic Zone including 9 industrial parks and 4 development areas (2013).

Surrounded by farmland and located about 60 km Northeast of Tokyo, Tsukuba is an early science city designed as a new satellite town and it was conceived totally as a government promoted scheme. Tsukuba Science City was built in order to ease congestion of Tokyo and to conduct high-level research and education by transferring national research and development, and educational institutions systematically. The city is now the largest science technology accumulation site among the country, where more than 300 public and private institutions and enterprises are located. (based on city website). TSC is segmented into the Research and Education District and the Suburban District.

financial | strategic

Scale campus: **L** (District or Town)

Land use area: **28.500 ha**

Density city: **757,5** inh./sq km

Transportation City:
Express railway (Tsukuba express is a rapid connection to Tokyo); intracity bus lines; express tollway (Joban expressway); served by Narita International Airport and Haneda Airport.

Distance campus to:

Narita International Airport	Tokyo	Tsukuba University
55 km	62 km	≤1 km
100'	69'	≤15'
Airport	City centre	University

physical | functional

Population campus: **214.000**
(Residents:214.000 including 20.000 public and private researchers)

Orgs. in campus: **583** aprox.
O1: >550 companies
O2: 2 universities
O3: 31 research institutes and centres

Facilities in campus:
F1: >100 restaurants and bars; 4 cultural facilities including a museum; 5 libraries
F2:146 parks; sport facilities; 48 km of 'pedestrian-only paths'
F3: Residential areas

Population city: **214.590** (Japan Statistics Bureau, 2010)

Employment city: **1.420.000** (in Ibaraki, JSP 2010)
Main employers-sector: 292.000 in Manufacture in Ibaraki / 20.000 public and private research jobs in Tsukuba

Tertiary education city:
2 universities inTSC (University of Tsukuba and Tsukuba University of Technology)

Amenities city:
A1-A2: >100 restaurants and bars; 4 cultural facilities including a museum; 5 libraries
A3:146 parks; sport facilities; 48 km of 'pedestrian-only paths'

Cluster base campus:
SciResearch + R&D: Technologies with a focus on Life Innovations and Green innovations.

Economic base city:
Key sectors: Life innovation and Green innovation.

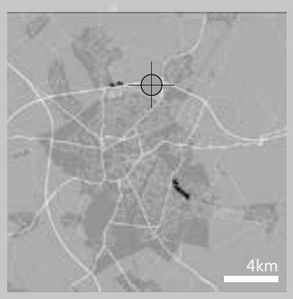
Touches

Cambridge Science Park

Cambridge, Cambridgeshire, UK

Code: **12-CSP**

Year: **1970**



Official denomination:

Permanent: as Science Park

Located at the north-east outskirt of the city, Cambridge Science Park was established by Trinity College in 1970 and is regarded as the UK's oldest and most prestigious science park, attracting new businesses, from small start-ups and spin-outs to subsidiaries of multinational corporations.The development of the park was a response to a report by the Mott Committee (a special Cambridge University Committee) published in 1969 that recommended an expansion of 'science-based industry' close to Cambridge to take maximum advantage of the concentration of scientific expertise, equipment and libraries and to increase feedback from industry into the Cambridge scientific community.

Cluster base campus:

R&D: Biomedical; Computer/ Telecoms; Consulting (Technical); Energy; Environmental; Financial, Business and other Non-Technical; Industrial Technologies; Materials.

Economic base city:

Consolidated: research and development, higher education, software consultancy, high value engineering and manufacturing, creative industries, pharmaceuticals, agriculture, processing and tourism. Emergent: The hi-tech sector is generating national strengths in creative industries and clean technologies; important growth sectors.

Vision city: V4-Slogans: 'Cambridge: where people matter - Cambridge: a good place to live, learn and work - Cambridge: caring for the planet'

Vision campus: V4-Motto: 40 years of Innovation

Google Earth, 2016

functional | physical

Population campus: **5.000** aprox.

P1-Employees: 5.000 aprox.

Orgs. in campus: **100** aprox.

O1:>100 companies

Facilities in campus:

F1: conference facilities; restaurant and bar
F2: health and fitness centre; recreational walks and jogging paths in 20 acres of landscaped grounds; squash courts
F3: child care nursery;

Population city: **123.867** (Census, 2011)

Employement city: **89.700** (employed, 2010)
Main employers-sector: 41% public sector; 26% Knowledge intensive jobs (teaching, research and health professions); 15% hi-tech sector

3rd education city: **2** universities (University of Cambridge, R-6 and the local campus of Anglia Ruskin University)

Amenities city:

A1:10 museums, 2 theatres; cinemas; architecture and heritage buildings, community centres, events and festivals
A2: bars and clubs; traditional pubs; markets
A3: swimming pools, parks and playgrounds, sports centres

Ext. Promoters: Unknow: In official economic reports, the University of Cambridge is addressed as one of the innovation strengths of the region and also as a major attraction for tourists. Nevertheless, the campus is not promoted by any mean in city/regional council websites.

Funding campus:

Private: The campus is property of Trinity College, which started the development and retains the majority ownership and control of the Park, and Trinity Hall since 2000. A joint venture between Trinity College and Trinity Hall (which owns the adjacent land) completes the remaining area of brown field development land adjacent to the Park.

Controllers campus:

Defined: CSP's Management is organised in five sections: Property Manager; Press and Media; Site Manager; Conference Centre Trinity Centre; Innovation Centre.

strategic | financial

Scale campus: **S** (Portfolio in an Area)

Land use area: **61,5 ha**

Density city: **3.040** inh./sq km (Census 2011* converted)

Transportation City:

Local Bus routes linking Park and Ride sites; Cambridgeshire Guided Busway bike infrastructure; railway network connecting with London; served by own airport Cambridge Airport.

Distance campus from:

Airport	City centre	University
6 km	6 km	5 km
70'	30'	30'
Cambridge Airport	Cambridge Railway Station	University of Cambridge

Sophia-Antipolis Park

Côte d'Azur Region (CDAz), FR

Disjoints

Code: **13-SAP**

Year: **1972**

Official denomination:

Permanent: as Park

Ext. promoters: Prom1: Invest in Côte d'Azur Team is the promotion and economic development agency of the Côte d'Azur Nice Sophia Antipolis region. They actively present the park as an important place for the economy of the region. Team Côte d'Azur is the entry point for investors and entrepreneurs who want access to economic, technological and institutional networks of the Alpes-Maritimes in general and especially Sophia Antipolis.

Funding campus:

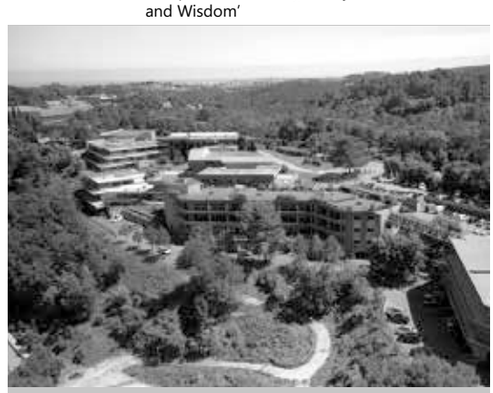
PPP originated Private: SYMISA is a Sophia Antipolis based public-private partnership formed by public authorities and local companies responsible for the future of the technology park. The State is land owner of almost one hundred hectares with urban development potential in this region. The first impulse for the creation of the technopole started from a private initiative of Pierre Laffitte, who conceived the project and was able to involve other key actors in its making. The organisation of Sophia Antipolis became wider, varied and made up of authoritative political and economically active players who contributed to legitimize Pierre Lafitte's project.

Controllers campus:

Defined: SYMISA is a Sophia Antipolis based public-private partnership that brings together public authorities and local companies responsible for the future of the technology park.

Vision city: V1-Strategy:Economic development strategy Region PACA (Provence-Alpes-Côte d'Azur)
V4-Motto: 'Innovating for better life'

Vision campus: V1-Plan: Sophia Antipolis 2030 planning and sustainable development
V2-Ambition: to give rise to a green area, in which 'knowledge workers' of various cultures and profiles could meet and exchange their knowledge.
V3-Concept: 'cross-fertilisation' between training, research and production, focusing on human values.
V4-Motto: 'Le Site intelligent d'Europe' (The European Smart Site); 'a City of Science, Culture and Wisdom'



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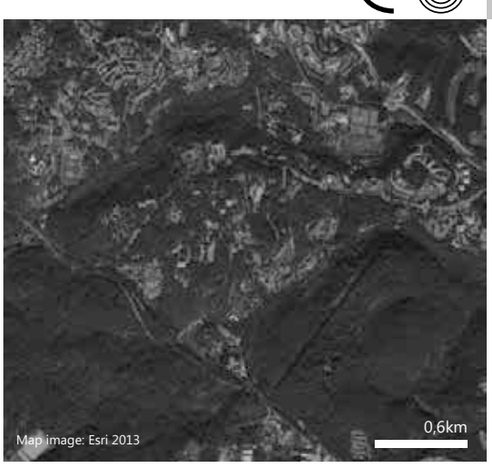
financial | strategic



Scale campus: **L** (District or Town)

Land use area: **2.320 ha** (60 ha occupied)

Density city: **155,7** inh./sq km (Provence Alpes CDAz)

Transportation City:
CDAz offers vary railway networks served by national or regional companies; and Regional Bus networks. The bus lines connect to Nice Airport. Envibus network connects 24 municipalities in the Urban community of Sophia Antipolis.

Distance campus from:

21 km	14 km	≤1 km
150'	120'	≤15'
Nice Côte d'Azur Airport	Gare d'Antibes	Sophia Antipolis University Campus STIC
Airport	City centre	University

physical | functional

Population campus: **30.000** est.

P1-Employees: 25.000 workers of whom 4.000 are public sector workers
P2-Students: 5.000 (2008)

Orgs. in campus: **1.415** est.

O1: 1.414 enterprises
O2: University of Nice-Sophia Antipolis

Facilities in campus:

F1
F2
F3

F2:open-air mall with a post office, bakery, restaurants, hairdresser, farmacy, Internet cafe, two supermarkets
F3:Residential area two hotels and a church (In the mixed area of Garbejaire)

Population city: **4.889.053** Provence Alpes CDAz region (2009)

Employment city: **1.877.500** (CDAz region 2009)
Main employers-sector: IT accounts for 46% of all new jobs generated; The services sector 25% of total jobs.

Tertiary education city:
1 university (University of Nice-Sophia Antipolis)
HEI: 7 (Polytech' Nice-Sophia, the Eurecom Institute; ICTS grad. program, the Ecole Nationale Supérieure des Mines de Paris, CERAM Sophia Antipolis, EDHEC and IAE)

Amenities city:

A1
A2
A3

A1: 84 museums, >500 cultural events a year including Cannes Festival; 150 art galleries; 2 opera houses; several theatres; dozen international schools
A2: 3,000 restaurants; many hotels and resorts
A3:40 kms of beach; 14 ski resorts; 9 natural parks

Sophia-Antipolis Park is located in Côte d'Azur region between the cities of Nice and Antibes. It is regarded as a multicultural, multidisciplinary community focused on innovation, which has served as the model for competitiveness clusters in France. (Based on Presentation Region Cote d'Azur)

Cluster base campus:
R&D: computer science, electronics and telecommunications (reresentative); life sciences and health (growing); natural sciences and the environment (small share).

Economic base city:
Key sectors: Information Technology; Aeronautics & Space; Life Sciences; Fragrances; Services and Corporate Functions; Call Centers; Tourism; Clean Technologies; Environmental Sciences. High attraction site for R&D and Services industry.

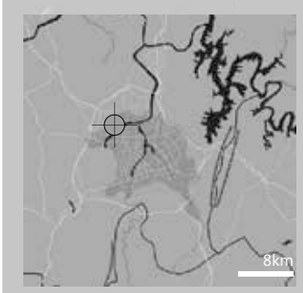
Taedok Science Town & Daedeok Innopolis

Equals

Daejeon, Hoseo, KR

Code: **14-TST**

Year: **1974-78**



Official denomination:

Changed: from Town (originally) to Special Research and Development Zone (2013)

Located 160 km south of Seoul, Taedok was entirely conceived, built and for many years managed by the Central Government and its subordinate local agencies, through the Ministry of science and technology (Based on Castells). The Science Town is regarded as an important milestone for science and technology in Korea. In 2013,, the INNOPOLIS Daedeok (a cluster of interconnected organizations in industry, academia and public and private research) brings these efforts to fruition. In 2000 the Daedeok Valley was announced with the first entry of hi-tech companies. In 2004 the region has been publicly designated and set aside by the government in accordance with the Special Act on the Support of Daedeok Special Research and Development Zone. (Based on Innopolis official website)

Cluster base campus:

R&D: Information technologies IT; Biotechnology; nanotechnology; Space technology; Energy and environmental technology.

Economic base city:

Consolidated: Research and Development, logistics, service and convention business.
Key sectors: The region has been publicly designated as Daedeok Special Research and Development Zone.

Vision city: V1-Policy= Daedeok Special Research and Development Zone.
V4-Slogan= It's Daejeon!

Vision campus:

V2-Ambition=To power Korea beyond the US$40,000 per capita GNP level while building an innovative economy.
V3-Concept/Pillars= through a dynamic ecosystem of knowledge creation, technology expansion and entrepreneurship.

By Yoo Chung (Own work) (CC BY-SA 3.0) via Wikimedia Commons

functional | physical

Population campus: **62.689**

P1-Employees= 62.689
(including 26.493 researchers and engineers, 2011)

Orgs. in campus: **275** aprox.

O1: 133 companies
O2: 5 HEIs including 4 universities
O3: 49 research institutes, 30 government agencies; 11 public institutions; 14 national agencies; 33 non-profit organizations.

Facilities in campus:

F1
F2
F3

F3: Housing

Population city: **1.500.000** (Daejeon, 2012)

Employement city: **726.000**
(Economically Active Population*)

3rd education city: **4** universities (KAIST, R-94; Chungnam National University; Hannam University; Korean University of Science and Technology)

Amenities city:

A1
A2
A3

A1: dozens Museums and art galleries; Daejeon observatory; archeological sites; 5 art & cultural centres; 10 cinemas; several festivals
A2: shopping malls; traditional markets
A3: several Parks and Eco-recreational Forests, Theme parks; Natural Spa; 2 large Sport facilities

Ext. Promoters: Prom2: Daejeon City promotes Innopolis as an important economic asset of the region within the Economy and Industry Bureau.

Funding campus:

Originally Public: Starting with establishment of the Daedeok Science Town, many government-sponsored research institutes were located there. Nowadays, the INNOPOLIS Daedeok is presented as cluster of interconnected organizations in industry, academia and public and private research and designated as a special Research and Development Zone.

Controllers campus:

Defined: The Innopolis is managed and controlled by INNOPOLIS Foundation (a non-profit organization, Legal basis for establishment: Article 46 of the Special Act on the Support of Daedeok Special Research and Development Zone) Its main role is the Commercialization of research achievements by creating a technology commercialization base, transferring technology and commercializing research results. The foundation is organised in two divisions: Planing & Management Division and Strategy Development division.

strategic | financial

Map image: Esri 2013

Scale campus: **L** (District or Town)

Land use area: **2.800 ha**

Density city: **2.780** inh./sq km

Transportation City: Railway (2 lines); Express Bus network; Airport limousine and taxi; intercity bus; expressway and subway lines;

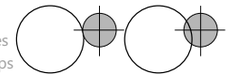
Distance campus from:

Airport	City centre	University
150 km	28 km	≤1 km
120'	45'	≤15'
Incheon Airport	Daejeon Station	KAIST and 3 other universities

Hsinchu Science and Industrial Park

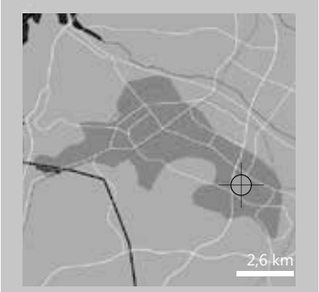
Hsinchu City, Northwestern Taiwan, TW

Touches
Overlaps



Code: **15-HSP**

Year: **1980**



Official denomination:

Permanent: Science and Industrial Park (sometimes regarded as High-tech Industrial park)

Ext. promoters: Prom1:Hsinchu City Government promotes itself as a Taiwan high-tech community and HSP is the flagship of the Business promotion; The Industrial Development Bureau, Ministry of Economic Affairs also promotes HSP as 'Science-based industrial parks' in their network of Industrial parks.

Funding campus:

Public: HSP is set up by The National Science Council and funded by the government driven by central government's policy initiative.

Controllers campus:

Defined: Under the jurisdiction of the National Science Council, the Science Park Administration (SPA) is given the responsibility of developing, operating and managing the park. The SPA is composed of six divisions--Planning, Investment Services, Labor Relations, Business, Construction Management and Land Development.

Vision city: V1-Policy: Regional spatial planning initiatives (HSP Special District,1981; Hsinchu Science City Development Plan , 1990; Taiwan Knowledge-based Flagship Park development project 2000s)
V2-Goals: Capitalize on technological advantages, and upgrade city administration and service; Showcase cultural creativity, and implement LOHAS city; Improve educational environment, and increase competitiveness; Take care of the disadvantaged, and actively protect the homeland.

Vision campus:
V2-Ambition: Nurture a quality investment environment conductive to the national economy.
V2-Goals: Improve the park as an investment environment; Promote across-the-board technology upgrade to enhance the competitiveness of park tenants; Build a low-carbon park running on green energy; create an environment conducive to sustainable development; Strengthen cooperation across industry, government, academia and research institutions to boost the park's R&D capacity
V3-Pillars: efficiency, honestly, competence and loyalty

Google Earth, 2016

financial | strategic

Scale campus: **M** (Area in a District)

Land use area: **653 ha**

Density city: **3,952** inh./sq km

Transportation City: Express way and railway network.

Distance campus to:

Taiwan Taoyuan International Airport	Hsinchu train station	National Chiao Tung University
50 km	5,5 km	2 km
160'	45'	5'
Airport	City centre	University

physical | functional

Population campus: **131.168**
P1-Employees: 131.168 (2012)

Orgs. in campus: **422**
O1: 422 companies

Facilities in campus:
F1
F2
F3
F2: parks, leisure areas, with basketball courts, tennis courts, swimming pools and golf driving ranges.
F3: residential areas with dormitories for singles and married couples; schools.

Population city: **393.557** (2006)

Employment city: **176.000** (2006)

Tertiary education city: **6** universities (National Tsing Hua University, National Chiao Tung University, National Hsinchu University of Education, Chung Hua University, Hsuan Chuang University, Yuanpei University)

Amenities city:
A1
A2
A3
A1:cultural heritage buildings and monuments; art museum
A3:17 km of coastline with several parks and fishing ports; the 18 peaks mountain as leisure site; 19ha green infrastructure in Grassland natural park and lake.

Located in northwestern Taiwan, the HSP was established as an environment for R&D, production, work, everyday life and even recreation in Hsinchu city and the county. In addition to its home base in Hsinchu, the HSP currently has five satellite parks. The HSC Development Plan project in the 1990s, and the Taiwan Knowledge-based Flagship Park development project in the 2000s were the two most important spatial planning and development projects in Hsinchu city-region that had been brought into national economic development plan. (Based on Wei-Ju Huang, 2013)

Cluster base campus:
R&D+Production:
semiconductor manufacturing, computer, telecommunication, and optoelectronics industries. Increasingly complete industry chain in LCD, LED and solar panel.

Economic base city:
Consolidated: semiconductor, optoelectronics industry, computer and peripherals, telecommunication, precision instrument and biotechnology.
Key sectors: The strategic priority industry Investment focuses on Commercial Technology; Fashion Boutique; Health Care and International Tourism.

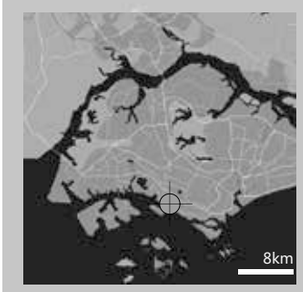
Contains

Singapore Science Park

Singapore City-State, SG

Code: **16-SSP**

Year: **1982**



Official denomination:

Permanent: as Science Park

Strategically located along the so-called Singapore's 'Technology Corridor', the park is in close proximity to research and tertiary institutions such as the National University of Singapore (NUS), National University Hospital (NUH) and one-north, Singapore's biomedical R&D hub. The SSP has been an integral part of the technology policy that underpins Singapore's economic growth strategy. Like many Asian science parks, one of the initial motivations of the SSP was to provide and upgrade local infrastructure to house Multi National Corporations as well as new industries that require proximity to higher education institutions (based on Koh et.al., 2005)

Cluster base campus:

R&D: Biomedical sciences; Information technology; Software development; Telecommunications; Electronics; Food technology; Flavours and fragrances; Materials and chemical.

Economic base city:

Key sectors: biomedical sciences, engineering, logistics, healthcare, maritime, info-communications and digital media.
Consolidated: 48% Electronics industry; 26% Manufacturing; 26% Financial business.
Emergent: centralised or 'shared services' such as IT, finance, and logistics.

Vision city:

V1-Plan: The Strategic Economic Plan (1991)
V2-Ambition: to attain the status and characteristics of a first league developed country within the next 30 to 40 years;
V3-Concepts: economic dynamism, a high quality of life, a strong national identity and the configuration of a global city.
V4-Motto: 'A Developed country in the first league'

Vision campus:

V2-Ambition: to be a focal point for R&D and innovation in Singapore and the region.
V2-Goal: to outline Singapore's willingness to develop high-tech industries.

Google Earth, 2016

functional | physical

Population campus: **9.000** aprox.

P-Other-Community: 9,000 researchers, engineers and support staff

Orgs. in campus: **350** aprox.

O1/O3: >350 MNCs, local companies and national institutions

Facilities in campus:

F1 — F1:Foodcourts, restaurants and cafeterias; Auditorium and conference facilties
F2 — F2: fitness centre with gym, swimming pool, tennis courts, aerobics and weights studios; Intra-park
F3 — F-Other: inner university bus shuttles

Population city: **5.353.494** (2012)

Employement city: **3.290.000** (*national labour force 2012)

3rd education city: **4** universities (the National University of Singapore, R-40; the Nanyang Technological University, R-169; the Singapore Management University; and the Singapore University of Technology and Design)

Amenities city:

A1 — A1:>50 Museums, several multi-cultural festivals
A2 — A2:>140 major shopping centres; several restaurants and bars that open 24/7; thematic attractions and parks (Universal studios; and the oceanarium)
A3 — A3:>300 parks and 4 natural reserves, 2800 trees/sq km

Ext. Promoters: Not found

Funding campus:

Public: SSP is developed with government funding. The provision of infrastructure went beyond just physical facilities, and included the creation—with government encouragement in the form of tax breaks and other incentives—of a supporting infrastructure for the MNCs. Singapore's science park strategy has until recently been driven largely by the government. Private sector participation was limited

Controllers campus:

Defined: In 1990, Jurong Town Corporation (In 2013 JTC Corporation, Singapore's principal developer and manager of industrial estates) established a subsidiary company Technology Parks Pte Ltd to manage the Singapore Science Park on a commercial basis.
Nowadays, Ascendas develops, manages and markets SSP. In 2002, Ascendas launched Ascendas Real Estate Investment Trust (A-REIT). The group has two divisions controlling the case; Development & Project Management; Property & Estate Management.

strategic | financial

Scale campus: **S** (Portfolio in an Area)

Land use area: **65 ha**

Density city: **7.497,9** inh./sq km

Transportation City:

Network of 4 Mass Rapid Transit - MRT train lines, Light rapid transit (LRT) or shorter trains. 387 bus services and 8 taxi companies; Changi International Airport

Distance campus from:

30 km	12 km	3 km
100'	60'	30'
Changi International Airport	Downtown Core Singapore	National University of Singapore
Airport	City centre	University

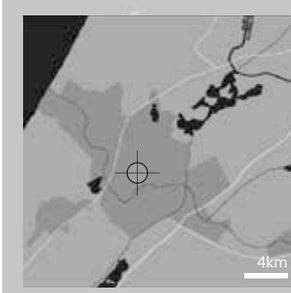
Leiden Bio Science Park

Leiden, South Holland, NL

Contains
Overlaps

Code: **17-LBSP**

Year: **1984**



Ext. promoters: Prom1:The Province of Ziud Holland outline Leiden Bioscience park as a cluster of knowledge intensive activity of a so-called knowledge axis in the region. The province authorities aim to develop this axis since they are of economic importance for the region.
Prom2: The Dutch Ministry of Economic Affairs addresses the park as one of the only six campuses of national importance in the Netherlands.

Funding campus:
PPP: Leiden Bio Science Park foundation was set up in 2006. The current stakeholders of the foundations are: City of Leiden; City of Oegstgeest; Leiden University; Leiden University Medical Center (LUMC); OV BSP, the entrepreneurial society of the park, representing the companies at the science park; Hogeschool Leiden (University of Applied Sciences); ROC Leiden (school for vocational training); Chamber of Commerce, The Hague area; Province of South-Holland; TNO, the Dutch Institute of Applied Technology; Naturalis Biodiversity Centre, the national museum of natural history.

Controllers campus:
Defined: The development of Leiden Bio Science Park is managed the Leiden Bio Science Park foundation. The foundation aims to attract new life sciences related companies and institutes, promote the park and strengthen its life science cluster by managing projects and stimulating the network. The park management of Leiden Bio Science Park is run by the entrepreneurial society OV BSP. The OV BSP aims to represent the interests of companies and institutes at Leiden Bio Science Park, promotes communication and anticipates current economic and social developments. The OV BSP is an intermediary for all the relevant authorities, either directly or through industry associations.

Vision city: V1-Strategy: Leiden Knowledge City (2012/13) International knowledge as a pillar.
V2- Ambition: develop a permanent place at the top of European knowledge regions whith life sciences and health as priorities.
V3-Concepts/pillars: Knowledge transfer, business environment and acquisition; Attractive student housing and living environments; Knowledge and culture; Care, health and social innovation; International branding and marketing; Excellent education and to the labor market.
V4-Motto: Leiden, Key to Discovery.

Vision campus:
V2-Ambition: to develop further into a more complete cluster in terms of size and quality, with companies and institutions in all phases of development, from research companies to production companies and suppliers.
V4-Motto: key to discovery.

Google Earth, 2016

Official denomination:
Permanent: as Science Park

financial | strategic

Scale campus: **M** (Area in a District)

Land use area: **110 ha** (75 ha including 2 plots around)

Density city: **5.471** inh./sq km

Transportation City: Interlocal Bus lines, National railway network,bike infrastructure, served by Amsterdam Schiphol Airport

Distance campus to:

Airport	City centre	University
30 km	**1 km**	**≤1 km**
30'	**<15'**	**≤15'**
Amsterdam Schiphol airport	Leiden Central Station	Leiden University

physical | functional

Population campus: **15.500**
P1-Employees:15.500 (2011)

Orgs. in campus: **154** est.
O1: 117 companies
O2: 7 educational institutes
O3: 12 research institutes; 9 care related orgs and 9 other orgs.

Facilities in campus:
F1 Not found
F2
F3

Population city: **120.088** (CBS, 2013)

Employment city: **59.985**
Main employer-sector: Human health and social: 15.613 and Education: 8.814
Main employers-staff: The LBSP, the Leiden University Medical Centre and Leiden University.

Tertiary education city:
1 university (Leiden University, R-79)
HEI: 1 (University of Applied Sciences Leiden)

Amenities city:
A1:12 museums, theatre,monuments, cultural centres; ancient alleyways, canals and moats
A2:shopping centre, market; congress centres;
A1
A2
A3

Leiden Bio Science Park is located next to the access point of the city, in close proximity to the city centre. It is regarded as the leading life sciences cluster in the Netherlands. LBSP is fully dedicated to biomedical life sciences and offers opportunities for both start-ups and established companies. (Based on presentation in official website)

Cluster base campus:
R&D: Medical life sciences.
SciResearch: Leiden University and LUMC focuses on 11 multidisciplinary themes, 5 of which are in life science and health.

Economic base city:
Key sectors: knowledge-intensive cluster. The coming years will focuses on the bio-based economy and innovation in healthcare. Also strengthen the services of insurance and pension opportunities. These sectors have a relationship with the Life Science sector, but will also broaden the economy.

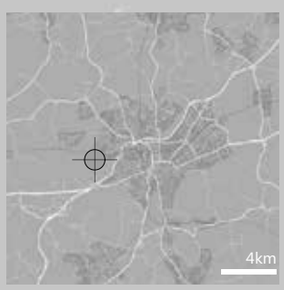
Surrey Research Park

Touches

Guildford, Surrey, UK

Code: **18-SYRP**

Year: **1984**



Official denomination:

Permanent: as Research Park

Surrey Research Park is located in the county town of Guildford, South East of England. The low density development is part of the University's campus in Guildford, and provides a working environment. (Based on official text from the website of the park)

Cluster base campus:

R&D: sciences, including social sciences, technologies and engineering activities.

Economic base city:

Key sectors: commercial, retail and leisure activities. The agricultural activities of the rural areas of Guildford make an important contribution to the economy.

Vision city: V1-Strategy: Guildford Borough Sustainable Community Strategy (SCS) (2009 – 2026) adopted in October 2009. This sets out the community's aspirations and establishes how partners intend to enhance the long-term economic, social and environmental wellbeing of the Borough.
V2-Ambition: An attractive, sustainable and prosperous Borough in which people fulfil their potential and the disadvantaged and vulnerable receive the support they need.

Vision campus:
V2-Ambition: to support companies involved in the commercialisation of a wide range of sciences, including social science, technologies, health related activities and engineering.

Google Earth, 2016

functional | physical

Population campus: Not found

Orgs. in campus: **110** aprox.
O1: 110 companies

Facilities in campus:

F1 — F1: Café
F2 — F2:Landscaped areas and park
F3

Population city: **129.000** (Guildford Borough, 2003)

Employement city: **75.000** employed (2010)
Main employers-sector: Construction 38.5%; Agriculture, Manufacture and Utilities 34% and Leisure 36%.

3rd education city: **2** universities (the University of Surrey; The University of Law)
HEI: 2 (Battersea College of Technology; and Guildford School of Acting)

Amenities city:

A1 — A1:>1,000 listed buildings and 38 Conservation Areas (cathedral; castles); museums; concert hall; theatre.
A2 — A2: traditional high street shopping; 2 shopping centres;restaurants and pubs
A3 — A3: gardens and parks; sport complex

Ext. Promoters: Not found

Funding campus:

Private: University of Surrey

Controllers campus:

Defined: Research Park Management. Its work had concentrated both on routine activities (e.g. promoting and marketing the park and attracting new tenants; property management; providing business services and facilities for tenants; public relations; raising finance and grants from Government and/or other agencies) and on
activities supporting tenants and the university (e.g. fostering links between the university and park tenants; fostering links between on-park firms; fostering links between on-park tenants and off-park firms; legal advice to tenants and the university concerning patents and licensing)

strategic | financial

Scale campus: **S** (Portfolio in an Area)

Land use area: **28,3 ha**

Density city: **2.151** inh./sq km (*USCB, 2010) *converted

Transportation City: Bus network (national, regional and local), railway with direct lines to London, Portsmouth, Reading and Gatwick. There are two trains each hour from Gatwick Airport to Guildford.

Distance campus from:

Airport	City centre	University
55 km	5 km	1,7 km
60'	30'	20'
Gatwick Airport	Guildford Station	University of Surrey

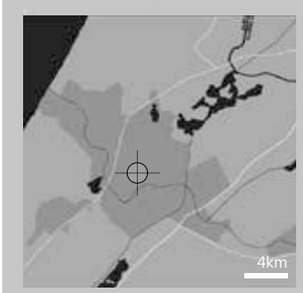
Western Australia Technology Park

Perth, Western Australia, AU

Contains

Code: **19-WATP**

Year: **1985**



Official denomination:

Permanent: as Technology Park

Ext. promoters: Prom1:The Department of Commerce within the Industry & innovation division, promotes WATP as Western Australia's premier location for technology driven and innovative organisations dedicated to information technology and telecommunications, renewable energy and clean technologies and life sciences.

Funding campus:

Public: The Park is an initiative that supports the caseives of Government of Western Australia. The Minister for Industry and Innovation, under the Industry and Technology Development Act 1998, considers all lease applications, extensions and transfers of land in the Park.

Controllers campus:

Defined: The Government of Western Australia, through the Department of Commerce, administers the Park, located in Bentley. New tenant applications are assessed by the Department and recommendations are made to the Minister for Commerce; Science and Innovation.

Vision city: V1-Strategy: Towards a Vision for Perth in 2029 (June, 2000)
V2-Ambition: connected and informed capital city with a unique identity and an economy that is diverse, resilient and adaptable
V3-Concept/Pillars: Unique Operating Environment; Advocacy & Engagement; Business Development will provide strong support and active encouragement for knowledge economy sectors, innovators and small businesses.

Vision campus:
V2-Goals: Support emerging and small local companies interested in developing and exporting technology based products and services; Encourage interaction between private and public sectors; Attract international technology focused companies and research organisations to locate their operations to Western Australia; Promote commercialisation of research and development within universities and the public and private sector; Create and maintain international and national strategic linkages for possible future joint project opportunities.

Google Earth, 2016

financial | strategic

Scale campus: **S** (Portfolio in an Area)

Land use area: **32 ha**

Density city: **305** inh./sq km

Transportation City: Capital Area Transit buses and Train Services; network of cycle and dual-use paths. The Free Transit Zone (FTZ) allows travel on all trains and buses within the city boundaries, with a SmartRider card. Perth is served by Perth Airport.

Distance campus to:

Perth Airport	Perth Station	Curtin University
13 km	9 km	2 km
45'	30'	20'
Airport	City centre	University

physical | functional

Population campus: **14.000** aprox.
P1-Employees: 14.000 aprox.

Orgs. in campus: **100** aprox.
O1/O2/O3: >100 organisations (including technology based industry, research and development, academia and support organisations)

Facilities in campus:
F1: Conference centre with meeting facilities; bar; Onsite bistro and catering service
F2: Landscaped gardens; Access to sports and recreational facilities including tennis, golf, yoga
F1
F2
F3

Population city: **1.644.849**
(Perth Statistical Division, 2013)

Employment city: **124.677**
Main employers-sector: Professional, Scientific and Technical Services accounts for 22.7% of total employmen (Australian Bureau of Statisitics (ABS) Census 2006 and 2011)

Tertiary education city:
5 universities (the University of Western Australia, R-189; Curtin University of Technology; Murdoch University; Edith Cowan University; and the University of Notre Dame)

Amenities city:
A1: several cultural centres, theatres; art galleries; museums; concert halls
A2: CBD with several restaurants; coffees, bars and night clubs
A3: sporting venues including premier sporting grounds and for leisure; parks and gardens; zoo; rivers.
A1
A2
A3

Located less than 6 kilometres from Perth; Western Australia's capital city, Technology Park is situated adjacent to the Curtin University of Technology. Technology Park is home to a number of organisations representing industry, R&D, academia, government and support services. Technology Park was opened in 1985 under provisions of the Technology and Industry Development Act. (Based on presentation in official website)

Cluster base campus:
R&D: Information technology and telecommunications, renewable energy and clean technologies and life sciences.

Economic base city:
Consolidated: Mining
Emergent: resource sector and non-residential construction activities.
Key sectors: Tourism and the creative industries are an important component within the City of Perth regional economy.

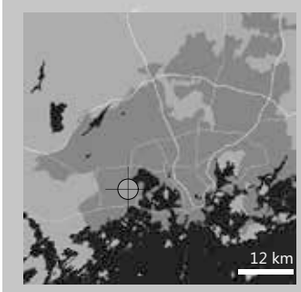
Otaniemi Science Park & Otaniemi Technology Hub

Contains

Espoo, Greater Helsinki, FI

Code: **20-OSP**

Year: **1985-86**



Official denomination:

In transition: from Science Park to Technology hub.

Otaniemi Science Park or Technology hub is located in Espoo, the second largest city in Finland and part of the capital region of Greater Helsinki. Otaniemi, which has grown up around TKK (Helsinki University of Technology) and VTT (Technical Research Centre of Finland), is the core of Finnish science and technology activities. The area is architecturally unique, boasting buildings designed by leading Finnish architects including Alvar Aalto. First to be built was the student campus of TKK. Starting in the 80s with the foundation of the Technology Park (In 2013, known as Technopolis Venture) and the Technology Centre Innopoli, a network of private office spaces have been built around TTK and VTT to support their actitivies.
In 2013, the area is referred as Otaniemi Technology Hub. With the merging three top Finnish universities; the University of Art and Design Helsinki (TaiK), the Helsinki University of Technology (TKK) and the Helsinki School of Economics (HSE), to encompass new joint research and teaching programs, new jobs and new area of commercial space. are expected.

Cluster base campus:

R&D: ICT clusters include: mobility-based software and webware, as well as nanotechnology and microelectonics.

Economic base city:

Consolidated: commerce, ICT and science.

Vision city: V1-Strategy: City of Espoo 3T Strategy (T3 area: Tapiola-Otaniemi-Keilaniemi)
V2-Ambition: with the merging three top Finnish universities by 2030 there will be 15,000 new jobs and 300,000 new m2 of commercial space.
V3-concept: Energizing Urban Ecosystems (EUE) program will create an internationally recognized and multidisciplinary hub of excellence for urban development in Finland. It will offer a globally networked cooperation platform for various R&D projects of urban planning and development.

Vision campus:
V2-Ambition: According to city of Espoo's T3 strategy plans Otaniemi will be integrated into the neighboring Keilaniemi and Tapiola districts creating a unique campus that combines research, art and business.
V4-Slogan: Bridging Innovation and Business. (Otaniemi Marketing, 2013)

J-P Kärnä (GFDL or CC-BY-SA-3.0), via Wikimedia Commons

functional | physical

Population campus: **32.000** aprox.
Other-Technology professionals: 16.000
P2-Students: 16.000

Orgs. in campus: **816** est.
O1:800 companies
O2: 5 schools of Technology of Aalto University and 12 TTK institutions
O3: 15 institutions

Facilities in campus:
F1: F1:Foodcourts, restaurants and cafeterias; Auditorium and conference facilties
F2: F2: fitness centre with gym, swimming pool, tennis courts, aerobics and weights studios; Intra-park
F3: F-Other: inner university bus shuttles

Population city: **310.000** (2012)

Employement city: **123.000** (*labour force 2010)
Main employer-sector: Public administration and services 25% of labour force.
Main employeers-staff: City of Espoo, Nokia, Inex Partners, Tieto Finland Oy, Jorvi Hospital, Orion Oyj, Tapiola Insurance Group, Aalto University, VTT

3rd education city: **1** university (Merge of Aalto University and Helsinki University of Technology – TKK)
HEI: 2 (Laurea- and Metropolia University of Applied Sciences)

Amenities city:
A1: A1: 14 libraries; 11 exhibitions in 4 museums; cultural centre with 648 public events
A2: A2:concert hall; theatre; 19 club and youth premises
A3: A3:14 activity parks; 144 municipal child day care centres; 7 sport locations and facilities including pools, football arenas, gyms, outdoor grounds; 10 harbours; 11 recreational islands; 21 beaches; 7 tennis courts; zoo.

Ext. Promoters: Prom1:Otaniemi Marketing; Aalto University; Technopolis; Otianiemi.Fi; City of Espoo Esbo; VTT Technical Research Centre of Finland; Aalto Entrepreneurship Society, Metropolia University of Apllied sciences; KCL laboratories; and RYM Oy- the Strategic centre for Science, Technology and Innovation of the built environment in Finland.

Funding campus:
Public & Private: In 1949, the Government of Finland purchased the lands of Otaniemi manor for use as the campus of the Helsinki University of Technology (TKK), now a significant part of Aalto University and the VTT Technical Research Centre of Finland. Land ownership in Otaniemi is concentrated almost entirely between two main parties. In addition to Aalto University Properties Ltd, the other significant owner of real estate in Otaniemi is Senate Properties (an enterprise under the Ministry of Finance)

Controllers campus:
Defined: University Campus is managed by Aalto University Properties Ltd. Besides, Otaniemi Marketing is a public-private partnership between key players in Otaniemi Technology Hub. It's key role is to assist foreign companies to find new opportunities, partnerships and open subsidiaries in Espoo (Aalto University; Technopolis; Otianiemi.Fi; City of Espoo Esbo; VTT Technical Research Centre of Finland; Aalto Entrepreneurship Society, Metropolia University of Apllied sciences;KCL laboratories). Nevertheless, their managing the development of the area is Not found.

strategic | financial

Scale campus: **M** (Area in a District)

Land use area: **100 ha* - 400 ha****
(*Science Park - **Technology hub)

Density city: **823** inh./sq km (on land)

Transportation City: Espoo is part of an integrated regional public transport area. Cycling and public transport (Bus, tram, Metro,Ferry and commuter train services) infrastructure. Espoo is served by Helsinki-Vantaa airport connected by bus.

Distance campus from:

Airport	City centre	University
23 km	10 km	≤1 km
60'	30'	≤15'
Helsinki Airport	Helsinki central railway station	Aalto University

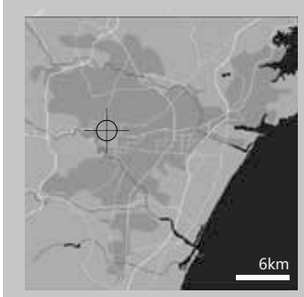
Sendai Technopolis & Izumi Park Town Industrial Park

Sendai city, Miyagi prefecture, JP

Equals

Code: **21- ST-IPT**

Year: **1986**



Official denomination:

Permanent as Technopolis and Park Town

Ext. promoters: Prom1: Sendai City, the Miyagi prefectural government, the Tohoku Bureau of Economy, Trade and Industry, and Tohoku University participate in the 'MEMS Park Consortium' (2004), located at IPT. The region makes concerted joint efforts to implement the transmission of information, human resource development, technical consultation, networking activities, etc. MEMS Park Consortium provides an open environment where researchers can share information and facilities.

Funding campus:

Public & Private Sendai Technopolis is funded with public capital within the MITI Economic plan. A master plan determined in mid-1989 was developed cooperatively by the Prefecture, University and private enterprises to secure regional technological development. It aims to promote innovative scientific and technological R&D through the creation of systematic institutional structure and the creation of specialized R&D companies which are private but are largely funded by public capital. Izumi Park Town Industrial Park's main developer is Mitsubishi Estate Co. Ltd.

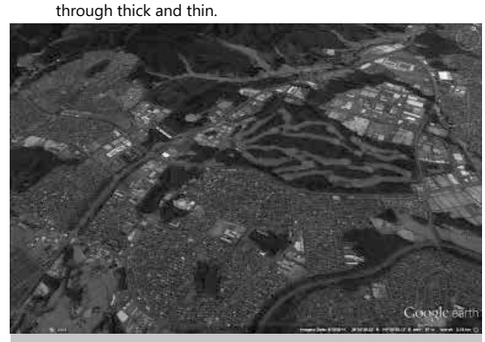
Controllers campus:

Defined: Izumi Park Town Service Co. Ltd. manages the properties of the park. In order to embody the ideal of Mitsubishi Estate as 'urban development and environmental development'

Vision city: V2-Ambition: attractive city for business (The city of Sendai Economic Affairs Bureau)
V3-Concept/Pillars: the 'new industry creation plan' focuses on: Manufacturing products based on Micro Electro Mechanical Systems Technology; International Welfare; and the Creative industry encouragin design and printing, and media contents and IT .
V4-Motto: 'Sendai, the best location for the future'

Vision campus:

V1-Plan: ST is framed in the Ministry of International Trade and Industry Visions for the 80s
V2-Ambition: This concept aims at promoting regional development and creating a new regional culture under the lead of industrial and academic progress.
V3-Concept: Technopolis or technology-intensive city, is a city that effectively combines an industrial sector composed of electronics, machinery and other most advanced technologies with an academic and a residential secotr.
V-4: IPT's slogan: 'Ideal Urban development for human' through thick and thin.



Google Earth, 2016

financial | strategic

Scale campus: **L** (District or Town)

Land use area: **1.070 ha**
(Izumi Industrial Park: 155 ha, Soft park: 16 ha)

Density city: **1.335** inh./sq km (2011)

Transportation City: Connection to Tokyo by Railway Tohoku 'Shinkansen' (Bullet Train); served by Sendai Airport. Public transportation system with interconnected subway lines, bus routes, and railways.

Distance campus to:

47 km	12 km	≤1 km
105'	30'	≤15'
Sendai Airport	Sendai Station	Miyagi University
Airport	City centre	University

physical | functional

Population campus: **53.431** (2012)

P1-Employees: 4.207 Faculty
P2-Students: 49.224
(50.000 was the population planned for ST)

Orgs. in campus: **60** est.

O1: 59 companies
O2: 1 University with 7 institutes.

Facilities in campus:

F1: Stores; cafes; restaurants; libraries; convention and exhibition centre
F2: Golf court; tennis courts
F3: hotels

Population city: **1.045.986**
(Japan Statistics Bureau, 2010)

Employment city:
546.366 (in Sendai, 2012)
Main employer-sector: Wholesales and retail trade with 143.135 jobs

Tertiary education city:
10 universities (including Tohoku University, R-120)

Amenities city:

A1:heritage buildings; museums; 4 main festivals
A2: hot string resorts; 6 shopping malls; shops and restaurants
A3: natural attractions as the river and several tree-lined streets and parks; sport facilities including stadium; Many pedestrian walkways; golf court

Sendai Technopolis (ST) is one of the series of new science cities created within Japan's technology program, a national plan master-minded by the Ministry of International Trade and Industry (MITI). ST includes Sendai City and Izumi City which together occuppy 81.000 ha. The main focus is in two sites: the Sendai Hokobu Research and Industrial Park (200 ha located 20 km north of central Sendai) and Izumi Park Town Industrial Town (IPT) including the 21st century Plaza located 10 km north of sendai's city centre. The Park Town started in the early 70s designed for living and working as a selft-contained new twon on 1300 ha developed by the Mitsubishi Estate Company. The industrial park started in the early 80s and it was planned for an industrial park and central office complex; but when the technopolis was designated, the plan was changed to take advantages of the subsidies.

Cluster base campus:

R&D + Production: ST focuses on electronics and mechatronics; new material; biotechnology and urban information. Most of the companies in IPT focuses on electronic and new materials.

Economic base city:

Consolidated: tertiary industries focusing on service and commerce.

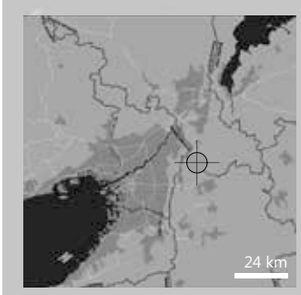
Disjoints

Kansai Science City

Kansai (unincorporated city between the prefectures of Nara, Kyoto and Osaka), JP

Code: **22-KSC**

Year: **1987**



Official denomination:

Changed: from Science City (origins) to Strategic General Special Zone (nowadays)

Known as 'Keihanna Science City' it was designed as a network of technology parks with some added cultural facilities. Located between the prefectures of Nara, Kyoto and Osaka to the west of Tokyo, KSC includes five cities. Its core is the Cultural and Scientific Research District, which includes research, cultural and residential facilities among others, and organised in 12 different zones developed in a cluster-type and phased approach. The construction Act of KSC was enacted in 1987. In 2011 KSC is Designated as the kansai Innovation International Strategic General Special Zone aimed to develop high-tech medical and life innovation industries.

Cluster base campus:

SciResearch:Information and Communications; materials and light quantum science; biotechnology and the living environment.

Economic base city:

Key sectors: high-tech medical and life innovation industries.

Vision city: V1-Plan: In March 2006, the Ministry of Land, Infrastructure and Transportation formulated 'Third Stage Plan' for 2015
V2-Goals: Construction of a creative future looking knowledge based city; 'Science for a Sustainable Society' as a basis for international R&D; Creation of new industry through ties among industry, academia, and government; Positioning the city as a cultural base and offering new cultural & scientific research; developing social infrastructure to support the city's activities.
V4-Motto: 'Challenging the Future…the New Cultural Capital, Keihanna'.

Vision campus:
V1-Plan: Construction Act. The 'Culture and Scientific Research District', in KSC, define the boundaries and facilities to accommodate R&D, culture and scientific research, residential and other activities.
V2-Ambition-Goals: The construction of KSC was undertaken to create a base for activities focusing on: Creating a base for new development in culture, science, and research; Contributing to the development of culture, science, and research in Japan and throughout the world, and to the development of the nationak economy; Foundation of the intellectual and creative city that opens doors for the future.
V4-Motto:Challenging the Future…the New Cultural Capital, Keihanna.

functional | physical

Population campus: **84.815*** (*Only in the Core District)

Other-Residents: 84.815 in its Core District (2010) (180.000 up to 210.000 residents was the population planned for KSC's Core District.)

Orgs. in campus: **133** est.

O1:> 110 companies and organizations
O2: 6 universities
O3:>17 main institutes and research facilities

Facilities in campus:

F1
F2
F3

F1-F3: Keihanna Plaza operates as a core facility of the science city, providing hotel accommodations and a convention center with the capacity to handle up to a thousand participants; and other public welfare and residential facilities.

Population city: **238.341** (Kansai Science City, 2010)
(410.000 was the population planned for KCS)

Employement city:

Not found

3rd education city:

6 universities (including Osaka University, R-119)

Amenities city:

A1
A2
A3

A2: Keihanna Plaza operates as a core facility of the
science city, providing hotel accommodations and a convention center with the capacity to handle up to a thousand participants; and other public welfare and residential facilities.

Ext. Promoters: Prom1: Kansai Science City Construction Promotion Office from the Ministry of Land, Infrastructure and Transportation indicates the direction of activities for KSC. Kansai Economic Federation (Kankeiren) was established in October 1946 as a private, non-profit organization. It consists of 1400 members drawn from representative businesses and organizations which pursue economic activity mainly in the Kansai region.

Funding campus:

PPP: The association to promote the area to outside industry was passed through an Act establishing KSC as a national project. Large companies have bought the land speculative resulted from the Japan's fiscal reevaluation in the 80s allowing incentives to the private sectors under special laws (such as lower land costs, property taxes and accelerated depreciation) as a solution for the government's fiscal problems.

Controllers campus:

Defined: The organistation of KSC involves; the prefectures and local govenrments; the Kansai Research Institute (private); Association of Kansai Culture, Academy and Research City. The institute was established in 1986 to plan and develop the city. It has 20 members; 10 from the prefectures, others from private companies, the national Housing corporation and others. Thier role is coordination and harmonization, since each prefecture's Ministry of Construction has power on its own. In 2013,, Keihanna Interaction Plaza Inc. is a core organization of Kansai Science City, responsible for establishing and managing several central facilities located in Kansai Science City.

strategic | financial

Scale campus: **L** (District or Town)

Land use area: **3.600 ha* - 15.00 ha****
(*Core District - **Kansai Science City)

Density city: **1.588** inh./sq km aprox. (Estimated by using from KSC area)

Transportation City:
Expressway connecting to Kansai International Airport; JR Line and private railway network

Distance campus from:

85 km	32 km	12 km
120'	70'	20'
Kansai International Airport	Kyoto's and to Osaka's Central Stations	Kansai Gaidai University (taken from core district)
Airport	City centre	University

Zhong Guan Cun Science Park

Beijing, CN

Overlaps

Ext. promoters:

Prom1: Vigorous promotion by the central state. Invest in Beijing actively promote the area as a Economic Development Zone to attract FDI.

Vision city:

V1-Strategy: Beijing city master plan (2004-2010)
V3-Concept/Pillars: capital city, metropolitan city, cultural city and livable city.

Funding campus:

Public and Private: The ownership structure of ZGCSP has changed over time according to changes in the development state in China: 'from state-owned enterprises to market-oriented enterprise; from domestic competition to international open competition'. 'The central government tentatively endorsed the ZGC trial by setting up an experimental zone in ZGC in 1988, and provided some tax relief for new enterprises. While granting unprecedented autonomy for these firms, the state made sure that it did not have to invest much capital or bear any responsibility for their failure' (Zhao, 1998) Because in the 1980s the users were largely universities, government ministries, and large state-owned enterprises, the academic backgrounds and research institution affiliation of the company founders were useful when negotiating contracts.

Controllers campus:

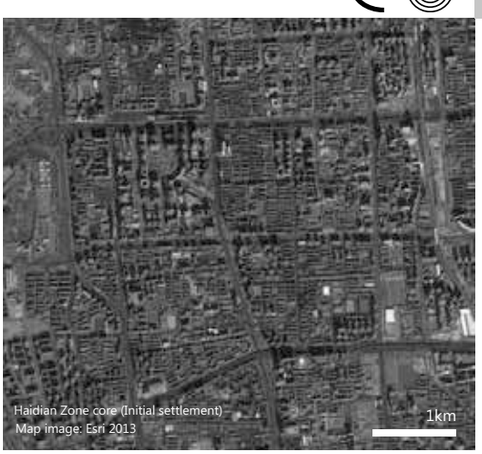
Defined: Zhongguancun Haidian Science Park Management Committee. Beijing Experimental Zone for New Technology Industries (BEZ) is a regulatory and supportive institute for ZGCSP. The Management Commission of BEZ handles affairs such as licensing, taxation, international trade, finance and investment, employment, and intellectual property for new-tech firms, largely in accordance with the stipulations of national policy but with slight local modifications.

Vision campus:

V1-Plan: The development of the ZGC Science Park underwent four major stages: (1) institutional innovation from the early 1980s to the late 1980s, (2) technological innovation from the late 1980s to the early 1990s, (3) market innovation from the early 1990s to the late 1990s, and (4) transition and reorientation from 1998 to the early 21st century.
V2-Ambition: to develop a heightened innovative environment.
/ V3-Concept: Entrepreneurial culture in ZGC has been a driving force: Proximity, shared resource arrangements, and an emerging cluster identity.

By Charlie fong (Own work) (Public domain), via Wikimedia Commons

financial | strategic



Haidian Zone core (Initial settlement)
Map image: Esri 2013

Scale campus: **L** (District or Town)

Land use area: **7.500 ha***
(ZGC Development Section at the core of 30,000 ha of Haidian Development Area)

Density city: **1.261** inh./sq km (2012)

Transportation City:

Railway network (9 lines); two high-speed rail lines; Beijing subway (17 lines); public bus, trolleybus and bus rapid transit lines; served by Beijing Capital International Airport

Distance campus to:

30 km	21,5 km	7 km
120'	55'	60'
Beijing Airport	Beijing Railway Station	Tsinghua University (from central Haidian district)
Airport	City centre	University

physical | functional

Population campus: Not found*
(*Population Haidian District: 2,2 million)

Orgs. in campus: **2.298** aprox.

O1: 8.000 enterprises; 155 listed companies
O2: 68 universities
O3: >230 independent scientific research institutions at the national and municipal level

Facilities in campus:

F1 Not found
F2
F3

Population city: **19'612.368** (National Bureau of Statisitics China, 2011)

Employment city:

Not found* (* 2.11% unemployement registered and 3,830,000 scientific and technical personnel in research insitutes, Beijing statistics Bureau, 2005)

Tertiary education city:

79 HEI (including Peking University, R-49; and Tsinghua University, R-71, Beijing Municipal Bureau of Statistics, 2005)

Amenities city:

A1: 58 cinemas, 34 museums, 26 public libraries, 328 art galleries and Cultural Centers, 36 art performance troupes, 20 archives in Beijing
A2
A3: 3.000 sport grounds

Code: **23-ZGCSP**

Year: **1988**

Official denomination:

Permanent: as Science Park

Zhongguancun (ZGC) Science Park, has been seen as the largest cluster of semiconductor, computer, and telecommunication firms in China. It is located in the Beijing Haidian District geographically situated in the northwestern part of Beijing city, in a band between the northwestern Third Ring Road and the northwestern Fourth Ring Road. China officially established Beijing Experimental Zone for New Technology Industries, widely known as the ZGC Science Park in 1988. In 2013,, the Zhongguancun Science Park, is composed of 5 different development areas (Haidian Development Area; Fengtai Development Area; Changping Development Area; Electronics Town Science and Technology Development Area; and Yizhuang Science and Technology Development Area) The Haidian Development Area is composed of seven sub-development areas.

Cluster base campus:

R&D+SciResearch: hi-tech business; Software R&D; Biotechnology; Science in the fields of electronic, information, biological pharmaceuticals, optics-machinery-electronics integration, new materials, new energy, and environmental science

R&D+Production: nano materials, information technology, bioengineering and new medicine, environmental protection and comprehensive utilization of resources, optics-machinery-electronics integration, space technology.

Economic base city:

Consolidated: tertiary industry (service sector) with 62.2% of the total GDP. Beijing has a fully integrated industrial structure covering fields of electronics, machinery, chemicals, light industry, textile and car manufacturing.
Key sectors: High tech and modern manufacturing industries.

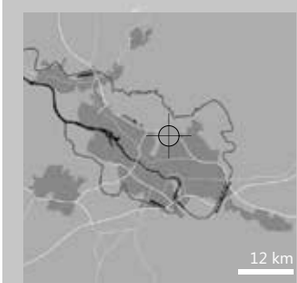
Touches

Technology Park Bremen & University of Bremen

Bremen, Bremen, DE

Code: **24-TPUB**

Year: **1988**



Official denomination:

Permanent: as Technology Park

Technology Park Bremen is a campus extension of the University of Bremen (established in 1971) which is built on in adjacent land. The technology park has attracted enterprises to locate there. These firms are linked to the University of Bremen via numerous cooperation agreements and joint projects. In 1988 the Bremen Senate made the decision of establishing a technology park. In 2013,, the area around the University is regarded as a key high-tech district in Northern Germany.

Cluster base campus:

R&D: Information and communications; technology; Aerospace; Logistics; Materials, microsystem and production engineering; Sensor and nanotechnology.

Economic base city:

Key sectors: mix of global industries of technological competence and innovation: automotive engineering, aviation and space travel, food and beverages, mobile technologies, life sciences, biotechnology and logistics.

Vision city: V1-Plan: Industry Master Plan Bremen. A contribution to structural Concept 2015
V3-Concept-Pillars: profiling of Bremen as a location for industry; securing and strengthening the industrial cores; stabilize the industry by Diversification and SME development; development of innovation, technology and research; addressing skills shortages through the promotion of education and training; the development of environmental economics; Climate change and energy supply, providing need-based Commercial and industrial areas; providing efficient Transport infrastructure and the intensification of national borders cooperation
V4-Slogan: Bremen – a wonderful place to live! A modern city with a great maritime past.

Vision campus:
V2-Ambition: to develop into a leading high-tech locations in Germany
V4-Motto: 'Where science and business grow together in tamdem'.

Google Earth, 2016

functional | physical

Population campus: **29.500** aprox.
P1-Employees: 6.500 aproximately and 3.000 staff University of Bremen
P2-Students: 20,000 University of Bremen

Orgs. in campus: **421 - 521** est.
O1: 400 - 500 enterprises
O2: 1 university
O3: 20 research centres and institutes

Facilities in campus:
F1 F1:conference facilities; restaurants and catering establishements; The area known as Glass Hall have numerous shops and service facilities
F2 F2: sport facilities
F3 F3: child care facilities; hotels

Population city: **548.319** (Bremen Statistical Office, 2011)

Employement city: **300.000** jobs (2011)
Main employers-sector: Manufacture with 46.245 jobs

3rd education city: **2** universities (The University of Bremen and Jacobs University Bremen)
HEI: 2 (the University of Applied Sciences in Bremen and Bremerhaven, the University of Fine Arts Bremen)

Amenities city:
A1 A1:several exhibitions, trade fairs, concerts, musicals venues; several museums and art galleries; heritage buildings
A2 A2: >1,000 cafés and bars, restaurants, bistros and pubs; several shops
A3 A3: 2,800 hectares of the city is open green space; 17 historical parks; 9 lakes; >130 sport clubs; sports games

Ext. Promoters: Prom1:Bremen Invest promotes TPUB as one of Germany's leading centres of high technology: a site for innovation and growth.

Funding campus:
PPP: involvement of the City of Bremen, Bremen Economic Development, the University of Bremen and the many companies who have chosen this site. More than 50 members – companies, research establishments, the University of Bremen and the Bremen Innovation and Technology Centre BITZ – give the Technology Park a profile and jointly work on qualitative development of the site to make it a specialised district for technology.

Controllers campus:
Defined: Technology Park Uni Bremen e.V. is the network within the Technology Park. The association works, with its members, to achieve forward-looking management of the Technology Park and fosters cooperation between the enterprises as well as partnerships between the research and business communities. Technology Park Uni Bremen e.V. has played a leading role in designing and developing the site into an urban district in its own right. It operates close ties within the Technology Park, the state of Bremen and its business development system. As a registered association, Technologiepark Uni Bremen e.V. is nevertheless independent.

strategic | financial

Scale campus: **S** (Portfolio in an Area)

Land use area: **170 ha**

Density city: **1.668** inh./sq km (Census 2011)

Transportation City: Bremen Strassenbahn AG operates around 380 modern trams and buses; Bremen City Airport connected by tram. Region connected by railway network (InterCityExpress, InterCity/EuroCity and InterRegio trains).

Distance campus from:

Airport	City centre	University
15 km	6 km	≤1 km
30'	12'	≤15'
Bremen Airport	Bremen Central Station	University of Bremen

Brandenburg Technical University Campus

Cottbus, Brandenburg, DE

Contains

Code: **25-BTUC**

Year: **1991**

Official denomination:

Permanent: as Campus

Ext. promoters: Prom1:the Economic Development board in the Federal state of Brandenburg; UNITEC GmbH - Society for Promotion of innovation and Technology transfer to the BTU Cottbus

Funding campus: **Public:** Brandenburg Technical University founded by the Federal State of Brandenburg in 1991.

Vision city: V1-Strategy:The 'Joint Innovation Strategy of the States of Berlin and Brandenburg (innoBB)' was adopted by the Berlin Senate and the Brandenburg Cabinet on 21 June 2011.
V2-Goal: to develop the cutting-edge fields, identified as important to both states in 2007, into the following cross-border clusters:Life Sciences & Healthcare; Energy Technology; Mobility, Transport and Logistics; ICT, Media, Creative Industries; and Photonics
V2-Ambition: to qualify the existing industry competence clusters in accordance with the current cluster strategy of the Federal State of Brandenburg./ V4-Slogan: Economic, science and technology location Cottbus.

Vision campus: V4-Motto: We live science

Controllers campus:

Defined: University Building Management Lausitz (Hochschul-Gebäude-Management-Lausitz or HGML) is the common management unit of the Brandenburg University of Technology Cottbus (BTU) and the Hochschule Lausitz (FH). The HGML is led by a board consisting of two equal members of the universities. The role of the HGML is to manage and to operate of all stations, real estate, buildings and industrial installations of both universities' facilities.

By Sane (Own work) (CC BY-SA 3.0), via Wikimedia Commons

financial | strategic

Scale campus: **M** (Area in a district)

Land use area: **30 ha**

Density city: **605** inh./sq km (2013)

Transportation City: Regional Railway connections; served by 3 airports (Berlin - Schönefeld, Berlin - Tegel, Dresden) Bus and tram lines.

Distance campus to:

Airport	City centre	University
119 km	**2,5 km**	**≤1 km**
120'	**10'**	**≤15'**
Berlin Schönefeld Airport	Cottbus Bahnhof	Brandenburg Technical University Cottbus

physical | functional

Population campus: **5.800** aprox.
P1-Employees: 1.156
P2-Students: 4.644 aprox.

Orgs. in campus: **14** aprox.
O2: 1 university with 4 faculties
O3: 13 institutions

Facilities in campus:
F1 F1:Library
F2 F2: Sport facilities
F3 F3: student housing

Population city: **99.470** (2013)

Employment city: **45.734** Jobholders (2011)
Main employers-sector: Service sector with 39.952 jobs.

Tertiary education city:
1 university (Brandenburg Technical University Cottbus)
HEI: 1 (Lausitz University of Applied Sciences)

Amenities city:
A1 A1:several theatres and stages; museums and galleries; art library; historical buildings; congress venues
A2 A3: parks and green areas (8,4 sq km of Sports and recreational areas); zoo
A3

The Brandenburg Technical University is located in the north of Cottbus, close to the city centre.The Brandenburg Technical University Cottbus was founded by the Federal State of Brandenburg in 1991 and in 2013, is regarded as an international innovation-oriented small technical university.

Cluster base campus:

SciResearch: Main topics are the environment, energy, materials, construction, and information and communication technology.

Economic base city:

Emergent: services, science and administration; technology and sciences. Research in the fields of 'Energy', 'Lightweight construction material' and 'Information and communication technology'.
Key sectors: Food; Media, Information and Communication Technology; Energy Industry and Technology; Automotive, Traffic Engineering; and Metal Production, Metal Machining and Processing, Mechatronics.

Touches

Zhangjiang High-Tech Park

Shanghai, CN

Code: **26-ZJHTP**

Year: **1992**

Official denomination:

Permanent: as Hi-Tech Park

ZJHT Park was established in 1992 as a national-level scientific park designed for high-technology development. However, the development of biotech industry did not start until 1996, when the agreement of National Shanghai Biotechnology and Pharmaceutical Industry Base (NSBPIB) was singed to support and promote the development of biotech industry in the Park. ZJHT Park is located in the middle part of Pudong New Area with a planned area of 25 sq km, comprising Technical Innovation Zone, Hi-Tech Industry Zone, Scientific Research and Education Zone, and Residential Zone.
Creative industries have been recognised as a key engine of economic growth in China in recent years. Actually, various Special Economic Zones (SEZs) like ZJHT have been established to attract advanced technology and talented people to China. (Based on Li and Hua 2009).

Cluster base campus:

SciResearch+R&D: Biomedical, information, integrated circuit, semiconductor, photoelectron, information security, software, culture, research, education, and network game and animation industries

Economic base city:

Consolidated: tertiary sector currently accounts for 58% of Shanghai's GDP
Key Sectors: Information services, financial services, commodities and trade, real estate; automotive and equipment (instruments) as new key manufacturing sectors, all closely related to high-technology industry and services than the old key industry sectors. (Based on Chen, 2012).

Vision city: V1-Plan: 12th five-year plan focuses on building the city into the four centres and a socialist modern international metropolis.
V2-Ambition:The municipal government is working towards building Shanghai into a modern metropolis and a global economic, financial, trading and shipping center by 2020.

Vision campus:
V1-Plan: 10-year 'focusing on Zhangjiang' strategy implemented in 2009
V3-Concept: Zhangjiang Hi-tech Park implemented the standardized investment attraction strategy, and gave priority to introduce and cultivate six types of enterprises: high-end industrial core technology; core products of high added value; overall controlling capacity in the industrial chain; integration solutions; domestic or overseas intellectual rights in the investment structure; and the features of low carbon and clean industry.

Google Earth, 2016

functional | physical

Population campus: **10.400** aprox.*
P1-Employees: 10.400 employees *in Biomedicine (2004)

Orgs. in campus: **430** est.
O1: 387 High-tech enterprises
O3: 43 R&D institutions

Facilities in campus:
F1 F1:commercial area
F2 F2: Zhangjiang Sports & Leisure Centre
F3 F3: Residential area

Population city: **23.000.000** (Civil Affairs Bureau, 2010)

Employement city: **6.480.000** (Civil Affairs Bureau, 2010)
Main employers-sector: Service sector with 3.530.000 workers

3rd education city: **66** HEIs

Amenities city:
A1 A1: 27 cultural centres; 112 art troupes; 28 public libraries; 50 archive offices; and 114 museums; several cultural and historical sites
A2 A2: several shopping areas and catering enteprises
A3 A3: green areas accounts for 38% of city area; several multifunctional sport venues including shanghai stadium;

Ext. Promoters: Prom1:The city of Pudong actively promotes ZJHTP as an economic development zone or a key site for investment in business.

Funding campus:
Public and Private: but most funding comes from the government. In 1999, Shanghai Municipal Committee and Municipal Government declared the strategy of 'Focus on Zhangjiang' and identified the leading industries of the Park, and ZJHT Park began to develop rapidly ever since. The main force in ZJHT Park's growth process in the biotech sector is the aggressive intervention of the park administration and the state and municipal governments by providing human resource and financial support.

Controllers campus:
Defined: Shanghai Zhangjiang (Group) Co., Ltd. owns and operates the Shanghai Zhangjiang Hi-Tech park. Shanghai Zhangjiang (Group) Co., Ltd. was formerly known as Zhangjiang Hi-Tech Park Development Co. Shanghai Zhangjiang (Group) Co., Ltd. was founded in 2007 and is based in Shanghai, China.

strategic | financial

Scale campus: **M** (Area in a District)

Land use area: **2.500 ha*** (*planned)

Density city: **3.632** inh./sq km (Civil Affairs Bureau, 2010)

Transportation City: Public transport system, largely based on metros, buses and taxis. (Shanghai Metro rapid-transit system and elevated light metro, Shanghai Bus, Trolleybuses, Shanghai Maglev Train, connecting Pudong to Pudong International Airport; 2 railways lines and The high-speed railway)

Distance campus from:

35 km	25 km	22 km
30'	60'	80'
Shaghai Pudong International Airport	Shanghai Railway Station	Shanghai Jiao Tong University
Airport	City centre	University

Taguspark

Lisbon, PT

Disjoints

Code: **27-TP**

Year: **1992**

Official denomination:

Permanent: Science and Technology Park

Taguspark is an science and technology park located in the Lisbon and Tagus Valley region, 15 km from Lisbon, at the junction of three municipalities: Oeiras, Cascais and Sintra.

Ext. promoters: Prom2:The Municipality of Lisboa identifies TP as a location in a map of a wide ecosystem of university, R & D and innovation of Lisbon within the initiative. The Map of Knowledge and Innovation Lisbon (MCIL) is a digital platform that allows to know and explore the ecosystem better.

Funding campus:

PPP: Taguspark was set up in 1992 by a government initiative, as a private company, with mixed capital. It has 16 shareholders, from the banking sector (31%), university and R&D institutions (26%), local authorities (17%), enterprise sector (17%), central government agencies (7%), and others (2%). The shareholders are active partners of the park as all of them are interested in reinforcing the regional innovation system in the Lisbon region.

Controllers campus:

Defined: Taguspark - Society for Promotion and Development of the Science and Technology Park Area of Lisbon, SA - is a private limited company. The main activity is the establishment, development, promotion and management of the Science and Technology Park as well as to provide all supporting services necessary to this activity. The governing bodies are organised in Councils, within with there are two offices responsible for the case: Planning area and Management control - Direction of projects, planning and urban development.

Vision city: V1-Plan: Lisbon City of Knowledge and Innovation.
V2-Ambition: Knowledge economy may contribute to generate skills and competitive advantages for cities and companies, creating and strengthening partnerships between the city's agents, improving cooperation between the public and private sectors, and strengthening the urban economy on the basis of knowledge and intangible capital.

Vision campus:
V2-Goals: Promoting a sustainable urban environment; Promoting the interaction between companies, Institutions of R & D and Universities; Developing business activities, of innovation and education; Promoting an environment of international competition.
V3-Concept: The Taguspark is developing a strategy for urban development through the creation of a Multi-functional Center to induce the urban life in the Taguspark including residential units in the Taguspark for students.

Fred mendonca from pt (GFDL, CC-BY-SA-3.0), via Wikimedia Commons

financial | strategic

Scale campus: **S** (Portfolio in an Area)

Land use area: **145 ha** (60 ha occupied)

Density city: **1.483** inh./sq km (Greater Lisbon)

Transportation City: Underground Metro system, trains, trams, buses, and taxis; served by Lisbon Airport connected by metro and buses.

Distance campus to:

22 km	18 km	≤1 km
50'	40'	≤15'
Lisbon Portela International Airport	Lisbon Rossio train Station	Open University and ITS
Airport	City centre	University

physical | functional

Population campus: **6.000**

P1-Employees: 6.000 workers

Orgs. in campus: **116** est.

O1: 77 companies; 23 service companies; 9 start-ups
O2: 2 universities
O3: 5 R&D institutes

Facilities in campus:

F1
F2
F3

F1: Congress Centre; Central facility with space for meetings and social interaction, exhibitions, seminaries, conferences and debates and commercial areas with restaurants, pharmacies and banks.

Population city: **2.042.477** Greater Lisbon (Eurostat, NUTS 3, 2011)

Employment city: **898.041** (Greater Lisbon, 2011)
Main employers-sector: >80% in the service sector

Tertiary education city:

3 universities (the University of Lisbon, the Technical University of Lisbon and the New University of Lisbon)

Amenities city:

A1
A2
A3

A1: 41 Museums, 182 art galleries; several heritage buildings, architecture; >9 international schools
A2: shops, restaurants, bar, cafes
A3: beaches, 11 main parks and gardens;

Cluster base campus:

R&D: technology-based companies, which are 80% in the domains of information, communication and electronics technologies, and 20% in the areas of bio-technology, environment, energy, materials and fine chemistry.

Economic base city:

Key sectors: Information and Communication Technologies (ICT); Renewable Energies; Tourism; Marine Economics; Creative Industries including Cinema and Audiovisuals and urban recovery; Health ,Provision of services for companies; Trade and finances.

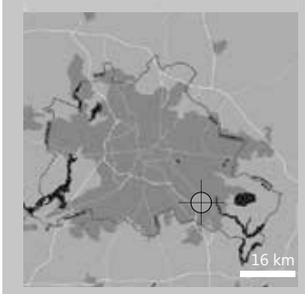
Berlin Adlershof Humboldt University

Berlin, Brandenburg, DE

Touches
Contains

Code: **28-BAHU**

Year: **1994**



Official denomination:

Permanent: as science and technology park (regarded some times as High-Tech Park)

Berlin Adlershof is regarded as one of Germany's most successful high-tech parks and site of the so-called Berlin's Media City.
It is located in Adlershof, a quarter at the south east of Berlin. At the core of the concept is a Science and Technology Park. In addition, six of the Berlin Humboldt University's scientific institutes are based here. Media City comprises commercial businesses, including shops, hotels and restaurants, a 66 hectare park and 380 residential buildings share the site with science, technology and media. The surrounding areas offer opportunity for further growth and development. The decision to develop an integrated landscape combining commerce and science was made on 12th March, 1991 by Berlin's federal state government.

Cluster base campus:

SciResearch+R&D: Photonics and Optics; Microsystems and Materials; IT and Media; Biotechnology and the Environment; Renewable Energies and Photovoltaics.

Economic base city:

Key sectors: Berlin is on the way to becoming a modern center of service providers. The city identifies locations of the future where it promotes knowledge-based sectors such as Electromobility
Emerging secotrs: The tourist industry is experiencing higher growth rates than any of the city's other business sectors.

Vision city: V1-Strategy:The 'Joint Innovation Strategy of the States of Berlin and Brandenburg (innoBB)' was adopted by the Berlin Senate and the Brandenburg Cabinet on 21 June 2011
V2-Ambititon: Berlin will become a forward-looking center of technology and service providers out of a traditional industrial city
V2-Goal:to develop the cutting-edge fields, identified as important to both states in 2007, into the following cross-border clusters:Life Sciences & Healthcare; Energy Technology; Mobility, Transport and Logistics; ICT, Media, Creative Industries; and Photonics.

Vision campus: V2-Ambition: Adlershof Projekt GmbH aims at further developing the city for Science, Business and Media and improving the quality of living.
V3-Concept: 'Living on campus' project which will provide 1,200 living quarters and a student housing project. It will add to the urban culture of the Adlershof site.
V4-Motto: City of Science, Business and Media.

By Brücke-Osteuropa (Own work) (CC BY 3.0), via Wikimedia Commons

Ext. Promoters: Prom1: City of Berlin promotes Adlershof Science and Technology Park in Berlin is promoted as home to one of the most successful high-technology projects in Germany.

Funding campus: **Public:** The decision to develop an integrated landscape combining commerce and science was made in 1991. Berlin's federal state government established the development agency Adlershof GmbH (Wista-Management Gmbh since 1994) and commissioned a master plan for the area. In August 1993, the Johannisthal Adlershof Aufbaugesellschaft mbh (JAAG, later to become Johannisthal Adlershof Aufbaugesellschaft mbh, BAAG) was awarded fiduciary duty and appointed development agency for the project. For 12 months, the 420 hectare compound was declared an urban development zone. Shareholders: Land Berlin (98,93 %),Wista-Management Gmbh (1,07%)

Controllers campus: **Defined:** The organisation of the campus is structure by a Committee of Shareholders' Meeting, Supervisory Board, Advisory Council. Wista-Management Gmbh is the operating company of the Science and Technology Park Berlin-Adlershof. It establishes, rents out and operates modern technology centres, makes properties available for sale, supports new start-ups, advises companies, promotes networking between science and business, encourages national and international cooperation, and handles PR for the entire Adlershof site. Adlershof Projekt GmbH is an urban development agency and trustee of the State of Berlin. Tasks: development, lead planning and management of urban land-use plans, lending support with land-use planning procedures, infrastructure project management and the administration of trust assets in the Adlershof development area. Selling of properties to companies and investors. Marketing for the entire Adlershof development area.

strategic | financial

functional | physical

Population campus: **23.380** aprox.
P1-Employees: 14.942 staff
P2-Students: 8.438

Orgs. in campus: **456** est.
O1: 445 companies
O2: Berlin Humboldt University including 6 scientific institutes
O3: 10 non-university scientific institutes

Facilities in campus:
F1
F2
F3

F1: Shops,and restaurants, café bars, and printing shops.
F2: a 66 hectare park, golf and tennis court
F3: hotels, 380 residential buildings, Day care centres and Medical Services

Population city: **3.501.872** (Eurostat, 2012)

Employement city: **1.759.000** (2013)
Main employers-sector: Public and private service provider accounts for 39,5% with 694,400 employees

3rd education city: **4** universities
HEIs: 35 (including 3 art colleges, an international business school)

Amenities city:
A1
A2
A3

A1: 56 theatres; 157 museums; 247 Movie theaters; major trade show and congress venues
A2: 4,650 restaurants, around 900 bars and 190 clubs and discotheques
A3: 435,680 Trees along roads; 74,094 garden plots; 1.842 playgrounds; 1.931 sports clubs; 20 courts

Scale campus: **M** (Area in a District)

Land use area: **467 ha**

Density city: **3.921** inh./sq km (Eurostat 2011 NUTS2)

Transportation City: Subway, suburban rail (U and S-Bahns), and bus lines. Two commercial airports: Berlin Tegel Airport (TXL) and Schönefeld Airport (SXF).

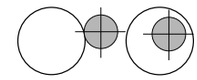
Distance campus from:

7 km	15 km	≤1 km
20'	35'	≤15'
Schoenefeld Airport, Berlin	Alexanderplatz, Mitte, Berlin	Berlin Humboldt University
Airport	City centre	University

Shenzhen Hi-Tech Industrial Park

Shenzhen, CN

Contains
Touches



Code: **29-SHIP**

Year: **1996**

Ext. promoters: Prom1: the Municipality of ShenZhen outline the park as an important location in the Economic profile of the city. The city profile itselft as 'strong in research and development of new technology and a good environment for industry have made the high-tech industry'. SHIP is actively supported by the Chinese central government and addressed as a key project for FDI as being located in an Especial Economic Zone.

Funding campus: **Public**: Supported by the municipal government, the industrial park provides integrated services to enterprises, researchers and investors.

Vision city:
V2-Ambition: Shenzhen will be a pilot zone for a national comprehensive reform program and will be built into a national economic hub
V3-Concept: As a State-level innovative city or model city with Chinese characteristics and an international metropolis, Shenzhen has chosen independent innovation as the dominant strategy for its future development.

Vision campus:
V2-Ambition: to promote the development of key industries and to establish complete industry chains in the park.
V3-Concept: innovation culture
V4-Motto: 'Fertile soil for business venturing and paradise for success'.

Controllers campus: **Defined:** The Shenzhen High-tech Industrial Park Office is deployed by the municipal government to provide administrative services in the park. Shenzhen Municipal Government is responsible for the leadership, decision-making, planning and macro-management of SHIP. The decision-making body is the Administrative Group of SHIP with the mayor of Shenzhen as the head, supervising the implementation of the relevant policies on the development of SHIP. The management body is the Administrative Office of SHIP, responsible for the routine daily work in SHIP. The service body includes the Service Centre of SHIP, the Service Centre of Shenzhen Virtual University Park and the Service Centre of Shenzhen Software Park providing the complete service to the enterprises and scientific research institutes in SHIP.

By Brücke-Osteuropa (Own work) (Public domain), via Wikimedia Commons

Official denomination:
Permanent: as Hi-tech Industrial Park

financial | strategic

Scale campus: **M** (Area in a district)

Land use area: **1.150 ha**

Density city: **5.265** inh./sq km (*estimated)

Transportation City: Railway network; Shenzhen metro; bus transportation; Shenzhen Bao'an International Airport

Distance campus to:

20 km	15 km	≤1 km
60'	50'	≤15'
Shenzhen Baoan International Airport	Futian CBD, Shenzhen	ShenZhen University
Airport	City centre	University

physical | functional

Population campus: **74.000** aprox.
P1-Employees: 74.000 workers

Orgs. in campus: **1.200** aprox.
O1: 1.200 enterprises

Facilities in campus:
F1: Auditorium; Conference Room, Restaurant, Cafeteria, Catering, Shops, Mall
F2: Golf Facilities, Sport Facilities
F3: Kinder Garden, Medical Services; Residential Areas (Houses, and Apartments)

Population city: **10.470.000** (2011)

Employment city: Not found (2.45% unemployment rate)

Tertiary education city:
8 HEIs (full-time based in Shenzhen. Another 122 HEI have branches in the city)

Amenities city:
A1: heritage sites; several cultural festivals
A2: 500 stores with floor space of more than 5,000 sq m; several restaurants and bars
A3:> 310 rivers and streams; 230 kilometers of coastline; several natural attractions in surrounding mountains, natural reserves and 15 golf clubs.

Shenzhen High-tech Industrial Park (SHIP) has been listed among China's five state-level high-tech parks. it is located in Nanshan District in Shenzhen. Shenzhen has been a touchstone for China's reform and opening-up policy since first special economic zone was established here in 1980. Supported by the municipal government, Shenzhen High-tech Industrial Park (SHIP) has grown into a high-tech center of research, development, investment and production. SHIP is part of the high-tech industry zone in shenZhen which includes Shenzhen Bay Area (where SHIP is located), Shiyan Area, South Guangming Area, Guanlan, Longhua Banxuegang Area, Baolong area, Great Industrial Area, Kuichong Dapeng Area, University City Area and Ecological Agriculture Area. Shenzhen Software Park is partly located in SHIP.

Cluster base campus:
R&D+Production: computer, telecommunication, networking, integrated circuit (IC), optical electronics, biological engineering and new materials

Economic base city:
Consolidated:The city is the high-tech and manufacturing hub of southern China, home to the world's fourth-busiest container port, and the fourth-busiest airport on the Chinese mainland.
Key sectors:The high-tech developments, financial services, modern logistics; foreign trade and cultural industries are mainstays of the city.

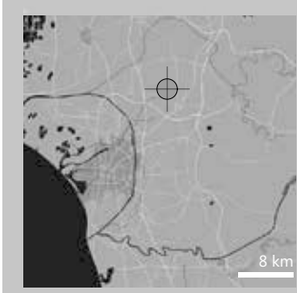
Disjoints

Tainan Science Park

Tainan City, TW

Code: **30-TSP**

Year: **1996**



Official denomination:

Permanent: as Science Park

Tainan Science Park is one of two sites of Southern Taiwan Science Park (STSP). The Tainan Science Park is situated between Xinshi, Shanhua and Anding District of Tainan City. In Taiwan, science parks are intended as special areas ideal for R&D, manufacturing and living that place equal emphasis on environmental integrity and economic expansion.

Cluster base campus:

R&D+Production: four industry clusters: Intergrated Circuits; Optoelectronics; Green Energy and Energy Saving; Biotechnology.

Economic base city:

Consolidated: manufacturing the construction, wholesale and retail trade, Lodging and Food, cultural and recreational and other service industries. The main manufacturing industries include machinery and equipment, metal product, plastic , transportation, food and beverage, textile, and basic metal.
Key sectors: technology and knowledge-based industry and business.

Vision city:

V2-Ambition: to stimulate our international competitiveness and to make Tainan an unique living city.
V3-Concept-Pillars: Tainan City Government proposes 'Ten Major Plans for Constructing Tainan': 'Investing Tainan', 'Water Resources and Tainan', 'Cultural Capital and Creative City', 'New Agricultural Life in Tainan', 'Low-carbon Green and Sustainable Tainan', 'Tainan with Love', 'Safe Tainan', 'Smart Tainan' and 'Convenient Tainan'.

Vision campus:

V2-Ambition: To become an Asian high-tech industrial and talent center that will foster growth among Park enterprises and create local jobs./ V4-Motto: Cultivating Southern Taiwan, Positioning Globally.

By 劉久弘 (Own work) (CC BY-SA 3.0), via Wikimedia Commons

functional | physical

Population campus: **60.531** aprox.
P1-Employees: 60.531

Orgs. in campus: **101** aprox.
O1: 101 companies

Facilities in campus:

F1: stores, restaurants
F2: Parks, The Sports and Recreation Center
F3: Community Center; Housing

Population city: **1.881.645** (Tainan City 2013)

Employement city: Not found

3rd education city: **15** HEIs: (including National Cheng Kung University (technology); and National University of Tainan)

Amenities city:

A1: museums; castles and temples; events and musical festivals
A2: shops; restaurants; traditional markets; cultural zone (with restaurants, shops, cafes, etc);
A3: Tainan coastal and recreation area; several parks;

Ext. Promoters:

Prom1:The city of Tainan promotes TSP as an important element for business investment in their industry profile.

Funding campus:

Public: The STSP Development Plan (which covered the Phase I Site of the Tainan Science Park) is an State initiative by the National Science Council was approved by the Executive Yuan in May 1995 to mark the beginning of southern Taiwan's high-tech development.

Controllers campus:

Defined: Under the jurisdiction of the National Science Council, the Science Park Administration (SPA) is given the responsibility of developing, operating and managing the park. The SPA is composed of six divisions--Planning, Investment Services, Labor Relations, Business, Construction Management and Land Development.

strategic | financial

Scale campus: **M** (Area in a District)

Land use area: **1.043 ha**

Density city: **858** inh./sq km (estimated)

Transportation City: Bus lines; railway network including Taiwan High Speed Rail; Tainan Airport

Distance campus from:

Airport	City centre	University
30 km	17 km	14 km
180'	70'	80'
Tainan Airport	Tainan Station	Tainan University of Technology

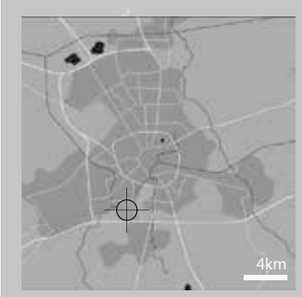
High-Tech Campus Eindhoven

Eindhoven, North Brabant, NL

Touches

Code: **31-HTCE**

Year: **1998**



Official denomination:

Changed: from Philips High Tech Campus to High Tech Campus Eindhoven in 2005

Ext. promoters:

Prom1:The establishment and continuous growth of High Tech Campus Eindhoven is the result of efforts by several (collaborative) partners: Philips; Dutch Ministry of Economic Affairs; Brainport Foundation; Municipality of Eindhoven; Brabant Development Agency (BOM); The cityregion Eindhoven (SRE). These parties aim is to develop the Eindhoven region as an internationally recognised technology region and HTCE as the central high tech hub.

Funding campus:

Private: The driving force behind the establishment of High Tech Campus Eindhoven was Philips, to act as a single location for all its national R&D activities. To further accelerate this process, Philips decided in 2003 to open up the Campus to other technological companies. The result was massive growth. Since March 2012 the Campus entered a new phase. High Tech Campus Eindhoven is, after being sold by Philips to Chalet Group, an independent organisation.

Controllers campus:

Defined: HTCE Site Management B.V. Founded by a large private company in 1998, High Tech Campus Eindhoven is since 2012 an independent organisation, after being sold by Philips to Chalet Group (Dutch consortium of private investors lead by Marcel Boekhoorn) the management unit was part of the deal. Philips remains on site, but its status changes from owner and manager to tenant.

Vision city:

V1-Strategy: Brainport 2020
V2-Ambition: to develop the Eindhoven region as an internationally recognised technology region; to position the Southeast Netherlands as a leader in the international knowledge economy.
V3-Concept/Pillars: People; Technology; Business; Basics; Governance ; and international cooperation.
V4-Motto: Top Economy, Smart Society
V4-Slogan: 'Leading in Technology' (Eindhoven City Region).

Vision campus:

V1-Plan: Campus master Plan 2003, Campus Masterplan 2010
V3-Concept: a technological Open Innovation ecosystem: The clustering of R&D companies where knowledge is central to an attractive and innovative environment. This environment is characterized by shared facilities make this knowledge possible and further strengthen. Collaboration, Partnership, and Share facilities to reduce costs are encouraged in campus
V4-Motto: 'The smartest square km in the Netherlands'.

http://www.microtoerisme.nl (CC BY-SA 3.0), via Wikimedia Commons

financial | strategic

Scale campus: **S** (Portfolio in an Area)

Land use area: **103 ha**

Density city: **2.499** inh./sq km (2011)

Transportation City: Interlocal Bus lines, National railway network,bike infrastructure, the 'Phileas'; a regional bus rapid transit; served by Eindhoven Airport

Distance campus to:

Airport	City centre	University
10-13 km	6 km	6,5 km
55'	25'	30'
Eindhoven Airport	Eindhoven Central Station	TU/e

physical | functional

Population campus: **8.000**

P1-Employees: 8.000

Orgs. in campus: **120**

O1/ O3: 120 companies and research institutes

Facilities in campus:

F1: Central facility with shops, restaurants, supermarket, cafes and bar, auditorium, conference center, Library and Wellness centre
F2: Sport forest and soccer fields, landscaped area with water corps, several bicycle and pedestrian paths
F3: Childcare centre.

Population city: **219.173** (CBS, 2013)

Employment city: **>145.000** (2009)
Main employer-sector: Consultancy, Research and Specialised services

Tertiary education city:

1 university (Technology University of Eindhoven - TU/e ,R-115)
HEI:2 (Fontys Fontys University of Applied Sciences and the Design Academy)

Amenities city:

A1: 4 large museums and serveral smaller museums; 1 international school; big public library
A2: shopping centre 'De Heuvel Galerie', amusement park 'Efteling'
A3: Genneper Parks, Stadswandelpark, Dommeldal and the wood at Strijp

High-Tech Campus has been designated by the Dutch Ministry of Economic Affairs as a 'campus of national significance'. The site is responsible for nearly 50% of all patent applications in the Netherlands (Source: EPO Worldwide Patent Statistical Database). The Campus site was originally founded as Philips Research Laboratories in the terrain where the Dutch section of the Philips research department or NatLab (Philips Physics Laboratory) was located; south-west of Eindhoven. After opening the site to other technology companies in 2003, the Philips Campus was renamed High Tech Campus Eindhoven.

Cluster base campus:

R&D + small Production: Health, Experience & Energy. Main technology domains: Microsystems; High Tech Systems; Embedded Systems; Med Tech; and Infotainment.

Economic base city:

Consolidated: high-tech industrial clusters include mechatronics, the automotive industry and electronics.
Emergent: industrial distribution, environmental technology, medical technology and information technology.

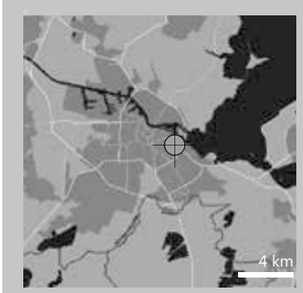
Science Park Amsterdam

Amsterdam, North Holland, NL

Touches
Contains

Code: **32-SPA**

Year: **2003**



Official denomination:

Permanent: as Science Park

Science Park Amsterdam is located in the eastern part of the city, not far from its historic centre. The park was designed to keep an urban character in which buildings, landscape and open space are closely interwoven. The area has been planned to accommodate education, research and business. In 1996, the City of Amsterdam designated Science Park Amsterdam as a major project and agreed to develop the location as a priority area for knowledge-intensive industry, eventually leading to the Masterplan in 2003.

Cluster base campus:

SciResearch: The academic cluster in Biology, Computer Sciences, Astronomy, Chemistry, Mathematics, Physics and Physical Geography

R&D: The research cluster into fields including multimedia, grid computing, visualization, system biology, nanophotonics, cryptology, smart grids, particle physics and microscopy. Many of the businesses operating from Science Park Amsterdam specializes in IT and Life Sciences.

Economic base city:

Consolidated: Finance is the most important sector in the Amsterdam Area, generating approximately 20% of the region's GDP and providing 15% of its jobs. Many international companies in Amsterdam, operate in sectors such as ICT, Fashion, Logistics, Creative and Financial & Business Services.
Emergent: advertising sector.

Vision city: V1- Strategy: Structural vision Amsterdam 2040 (Structurrvisie Amsterdam 2040, DRO 2011)
V2-Ambition: strengthening the economy of the Amsterdam Metropolitan Area (Amsterdam Economic Board)
V3-Concept-Pillars: seven main economic clusters were designated for the Amsterdam Area. Sustainability, the primary driving force behind innovation, is a significant theme evident in all of them. The clusters are: Creative Industries; ICT/e-Science; Life Sciences & Health; Financial & Business Services; Logistics; Flowers & Food; Tourism & Conferences
V4- Motto: 'Structural Amsterdam 2040: economically strong and sustainable'

Vision campus: V1-Plan: Science Park Amsterdam Masterplan 2003
V3-Concept: In the urban development plans, Science Park Amsterdam is designed like a network: a structure of semi-public meeting places in and between the buildings, connected by system of public open spaces
V4-Motto: a place where Education, Exploring and Enterprising interact.

By Jvhertum (Own work) (CC BY-SA 3.0), via Wikimedia Commons

functional | physical

Population campus: **6.000** aprox.* (*excluding companies)

P1-Employees: 1.200 researchers and 1.500 staff from UvA Faculty of Sciences
P2-Students: 2.500 from UvA Faculty of Sciences and 600 - 900 students from Amsterdam University College

Orgs. in campus: **84** est.

O1: 80 high-tech, knowledge-intensive companies
O2: UvA Faculty of Science (4 departments); Amsterdam University College
O3: 3 Netherlands Organisation for Scientific Research institute.

Facilities in campus:

F1
F2
F3

F1: catering and conference facilities
F2: sports amenities
F3: student housing
F-Plan: a hotel and conference facilities are under construction.

Population city: **801.847** (CBS, 2013)

Employement city: **422.000** *labour force (2011)
Main employers-sector: the Dutch financial sector employs 270.000 people

3rd education city: **2** universities (the University of Amsterdam, R-92; and the VU University Amsterdam, R-159)
HEI:17 institutions of applied sciences.

Amenities city:

A1
A2
A3

A1: 51 museums; 55 Theatres and concert halls; 1 Music theatre; 15 cinemas;
A2: 32 markets; 6.159 shops; 1.515 cafés and bars; 36 clubs; 1,150 restaurants; 398 hotels;
A3: 40 parks; 165 canals; Zoo; 5 campsites.

Ext. Promoters:

Prom1: Amsterdam Development Corporation; Amsterdam Economic Board presents SPA as one of the Assets of Amsterdam metropolitan area in The Knowledge and Innovation Agenda for the Amsterdam Metropolitan Area.

Funding campus:

PPP: Science Park Amsterdam is a joint development being fronted by the University of Amsterdam (UvA), the City of Amsterdam and the Netherlands Organisation for Scientific Research. Altogether own the land.

Controllers campus:

Defined: the Amsterdam Development Corporation (Ontwikkelingsbedrijf Gemeente Amsterdam - OGA) is responsible for the development of Science Park Amsterdam on behalf of the university of Amsterdam and the City. that means that the OGA acts as the client for all required public work, and it prepares the required leases for all areas.

strategic | financial

Scale campus: **S** (Portfolio in an Area)

Land use area: **70 ha**

Density city: **4.791** inh./sq km (Gemeente Amsterdam, 2012)

Transportation City:

Tram lines; bus lines; and metro lines;12 ferries; bike infrastructure; national railway; served by Schiphol Airport

Distance campus from:

Airport	City centre	University
24 km	5,5 km	≤1 km
30'	10'	≤15'
Schiphol Airport	Amsterdam central Station	University of Amsterdam

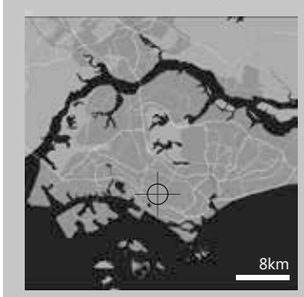
Biopolis

Singapore City-State, SG

Contains

Code: **33-BPS**

Year: **2003**



Ext. promoters:

Prom1:The Ministry Of Trade and Industry, Singapore Government and A*STAR, the Agency for Science, Technology and Research, promote Biopolis, Fusionopolis in One-North location.

Funding campus:

Public: Government initiative. The masterplan for the area One North was commissioned by the Science Hub Development Group (SHDG) and Juron Town Corporation (JTC)

Controllers campus:

Defined: JTC Corporation, is Singapore's principal developer and manager of industrial estates and their related facilities. Its mission is to plan, promote and develop a dynamic industrial landscape, in support of Singapore's economic advancement. (Parent agency: The Ministry Of Trade and Industry, Singapore Government)

Vision city:

V1-Plan: The Strategic Economic Plan (1991)
V2-Ambition: to attain the status and characteristics of a first league developed country within the next 30 to 40 years;
V3-Concepts: economic dynamism, a high quality of life, a strong national identity and the configuration of a global city.
V4-Motto: 'A Developed country in the first league'

Vision campus:

V1-Plan: One North Masterplan 2001 - 2021
V2-Ambition: to meet government's current plan to develop Singapore into a bio-medical hub and to create new engines of growth.
V3-Concept: The Biopolis master-plan bears reference to the flowing ground form, undulating terrain and the dramatic skyline. The building forms are never rectilinear, thus reflecting the dynamism of the interaction between physical and human 'force-fields'.

By Henry Leong Him Woh (CC BY-SA 2.0), via Wikimedia Commons

Official denomination:

Permanent: Biopolis (referred as a cluster and/or location)

financial | strategic

Scale campus: **S** (Portfolio in an Area)

Land use area: **65 ha**

Density city: **7.497,9** inh./sq km

Transportation City: Network of 4 Mass Rapid Transit - MRT train lines, Light rapid transit (LRT) or shorter trains. 387 bus services and 8 taxi companies; Changi International Airport

Distance campus to:

28 km	9 km	2,5 km
70'	40'	20'
Changi International Airport	Downtown Core Singapore	National University of Singapore and UTD
Airport	City centre	University

physical | functional

Population campus: **2.000** aprox.

P-1 Employees: 2.000 scientists, researchers, technicians and administrators

Orgs. in campus: Not found

O1/O3: public and private biomedical research institutes and organisations

Facilities in campus: Not found

F1

F2

F3

Population city: **5.353.494** (2012)

Employment city: **3.290.000** (*national labour force 2012)

Tertiary education city: **4** universities (the National University of Singapore, R-40; the Nanyang Technological University, R-169; the Singapore Management University; and the Singapore University of Technology and Design)

Amenities city:

A1: A1:>50 Museums, several multi-cultural festivals

A2: A2:>140 major shopping centres; several restaurants and bars that open 24/7; thematic attractions and parks (Universal studios; and the oceanarium)

A3: A3:>300 parks and 4 natural reserves, 2800 trees/sq km

Biopolis was conceived as the cornerstone of a vision to build up the biomedical sciences as a key pillar of the Singapore economy. It accommodates public as well as corporate research laboratories in one location of the biomedical development called 'One North.' Biopolis and later on, Fusionopolis located next to it, are in 2013 regarded as part of a greater eco-system in One-North, where working, living, and playing comes together as one. The development of Biopolis was undertaken in 5 phases since 2003.

Cluster base campus:

R&D+Production: biotechnology and biomedical sciences (life sciences value chain, from R&D to manufacturing and healthcare delivery)

Economic base city:

Key sectors: biomedical sciences, engineering, logistics, healthcare, maritime, info-communications and digital media.
Consolidated: 48% Electronics industry; 26% Manufacturing; 26% Financial business
Emergent: centralised or 'shared services' such as IT, finance, and logistics.

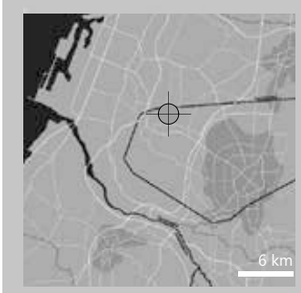
Disjoints

Taichung Science Park

Taichung,Central Taiwan, TW

Code: **34-TCSP**

Year: **2003**



Official denomination:

Permanent: as Science Park

Taichung Science Park is one of four sites of CentralTaiwan Science Park located in Taichung City at the border between Daya and Shituen Districts. On September 23, 2002, the National Science Council ratified the foundation of Central Taiwan Science Park. The construction of Taichung Park started ten months after the plan was ratified. On July 28, 2003, private firms were introduced.

Cluster base campus:

R&D+Production: semiconductors, optoelectronics, IC and precision machinery ventures.

Economic base city:

Consolidated: manufacturing; service-industry markets
Emergent: high-tech industries. In 2013, the broad-based economy continues to thrive in a variety of sectors--from aerospace to agriculture--thanks to continuing, growing investments from local and international companies.

Vision city:

V4-Motto: 'Taichung: Creative, Alive, Cultural' It is The Intelligent Communities of the Year 2013.

Vision campus:

V2-Ambition: is to build a green park, featuring 'sustainable development' and 'localized charm'
V4-Motto: Taichung Park: 'a Prosperity Powerhouse of Central Taiwan'

By Fcuk1203 (Own work) (CC BY-SA 3.0), via Wikimedia Commons

functional | physical

Population campus: **21.862** aprox.
P1-Employees:21.862 (2011)

Orgs. in campus: **86** aprox.
E1: 86 companies (2011)

Facilities in campus:

F1 Not found
F2
F3

Population city: **1.081.500** est.* (2010) *Only Taichung City

Employement city: **465.000** (Taichung city, 2007)
Main employers-sector: Service sector

3rd education city: **14** Universities (including two medical universities)
HEIs: 17 (1 nursing college, 3 colleges, 1 junior college, 9 vocational schools, 3 institutes of technology)

Amenities city:

A1: 2 international schools; 7 museums; 5 art galleries and centres; several cinemas
A2: several comercial districts and shops; traditional markets; art district; restaurants and bars
A3: sport facilities, including sports stadiums, baseball fields, golf courses, swimming pools, public basketball courts and soccer fields, rock-climbing walls, bicycling paths, hiking trails and public parks

Ext. Promoters:

Prom1: Taichung City government promotes the TCSP as an important development project in the economic profile of the region.

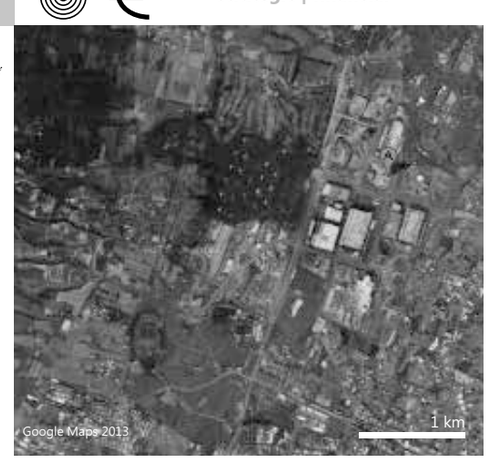
Funding campus:

Public: founded by the National Science Council

Controllers campus:

Defined: Under the jurisdiction of the National Science Council, the Science Park Administration (SPA) is given the responsibility of developing, operating and managing the park. The SPA is composed of six divisions--Planning, Investment Services, Labor Relations, Business, Construction Management and Land Development.

strategic | financial



Scale campus: **M** (Area in a District)

Land use area: **413 ha**

Density city: **1.200** inh./sq km (estimated)

Transportation City:
National railway network and Taiwan High Speed Rail (THSR); Taoyuan International Airport connected by bus and HSR; Taichung Airport connected by bus; Kaohsiung International Airport connected by railway; Bus network

Distance campus from:

7 km	13 km	12 km
60'	120'	120'
Taichung Ching-Chuang-Kang Airport	Taichung Station in central district	National Taichung Educational University
Airport	City centre	University

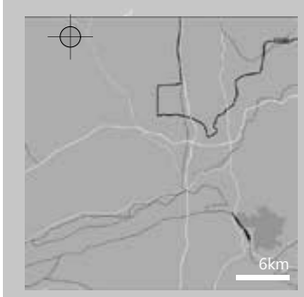
Biocant Park

Cantanhede, Coimbra, PT

Disjoints

Code: **35-BP**

Year: **2005**



Ext. promoters:

Prom1: the Municipality of Cantanhede, the Center for Neuroscience and Cell Biology of the University of Coimbra and Associação Beira Atlântico Parque.

Vision city:

V1-Plan: Municipal The Master Plan is Currently under revision and expected it to be Concluded in November 2013

Funding campus:

PPP: investments by the Municipality of Cantanhede and by the Center for Neuroscience and Cell Biology of Coimbra. Taking advantage of the last years' national investment in Life Sciences, it was possible to set out an integrated development strategy to promote entrepreneurship and economic growth.

Vision campus:

V2-Ambition:to create value for the region and for the country by stimulating investment and commercial initiatives based in scientific and technological knowledge.
V4-Motto: Creating Value in Biotechnology.

Controllers campus:

Defined: Beira Antlantic Park Association (Associação Beira Atlântico Parque) is the managing institution of the biotechnological park, in association with five municipalities and several institutions. The association is private non-profit organization that integrates multiple investors with capital mainly owned by the Municipality of Cantanhede

Google, Street view September 2014

financial | strategic

Scale campus: **S** (Portfolio in an Area)

Land use area: Not found

Density city: Not found

Transportation City: Bus network and the Coimbra trolleybus system; accessed by railway network and served by the airport 'Aeródromo Municipal Bissaya Barreto'

Distance campus to:

Airport	City centre	University
40 km	30 km	32 km
35'	30'	30'
Coimbra airport	Coimbra-A railway station	University of Coimbra

physical | functional

Population campus: **210** aprox.

P1-employees: 60 workers and 150 researchers from the Center for Neuroscience and Cell Biology of Coimbra - CNC

Orgs. in campus: **37** aprox.

O1:28 permanent and affiliated biotechnology companies
O3: 8 specialised technology transfer centres; 1 venture capital firm

Facilities in campus:

F1: bar and restaurants; conference centre

F1
F2
F3

Population city: **38.032** (Cantanhede 2013)

Employment city: **17.920** (Cantanhede)
Main employer-sector: 36% in the agriculture sector, 26% in Manufacturing and 38% in Service

Tertiary education city:
1 university (University of Coimbra)

Amenities city:

A1: several museums and monuments; art galleries and antique shops
A2: shops, bar and restaurants;
A3:parks and gardens; leisure and sport facilities including stadium

A1
A2
A3

Official denomination:

Permanent: as Park

Biocant is located 25km from Coimbra and it was created through a partnership between the Municipality of Cantanhede and the Center for Neuroscience and Cell Biology of Coimbra - CNC (a National Research Centre linked to the University of Coimbra). BIOCANT Park is the first Portuguese venue entirely devoted to Biotechnology. (Based on Carvhalo, 2013)

Cluster base campus:

R&D: Biotechnology and Life Sciences

Economic base city:

Consolidated: Coimbra has a service-based economy (retail, horeca, education,public administration) resulted from the decline of its manufacturing activity (ceramics, food and textiles) during the last decades.

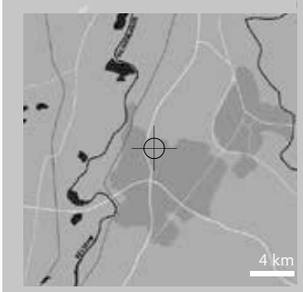
Touches

Chemelot Campus

Sittard-Geleen, Limburg, NL

Code: **36-CRDP**

Year: **2005**



Official denomination:

Permanent: as Campus and Industrial Park.

Chemelot R&D Park is located in Sittard-Geleen; south of the Netherlands. With two large chemical companies (DSM and SABIC) on the site, the name Chemelot was introduced in 2002 and comprises the Industrial Park and the Campus. At the end of 2004, based on new DSM's strategy that decentralized research activities from the business activities, DSM, the Municipality of Sittard-Geleen, the province of Limburg and the trade unions, made and agreement with the aim to develop the former DSM site into an open industrial site for chemical production, research and development. The name DSM Research disappeared, the research site is now called Chemelot Campus; accomodating DSM, SABIC and, increasingly, other companies' activities in the field of research and development.

Cluster base campus:

R&D+Production: Chemical industries. The focus is on five primary sectors: performance materials, bio-based materials, biomedical materials, biotechnology (biosynthesis) and analytical R&D support.

Economic base city:

Key sectors: industry and construction; trade and services.
Consolidated: chemical, automotive and logistics. at international level. Construction, retail, hospitality, healthcare, commercial services and other services sectors strongly represented at regional-local level.

Vision city:

V1-Strategy: Brainport 2020 program in South Limburg and Limburg Economic Development (LED)
V2-Ambition: Brainport 2020 aims to position the Southeast Netherlands as a leader in the international knowledge economy. The three central municipalities in South Limburg (Heerlen, Maastricht and Sittard-Geleen), jointly with the State, business and educational institutions, will cooperate economically.
V3-Concept/ Pillars: People; Technology; Business; Basics; Governance ; and international cooperation.V4-Motto: Top Economy, Smart Society.

Vision campus:

V2-Ambition: Chemelot has been planned around one central idea to bring together the knowledge and skills normally found only in major organizations, and to apply these within a flexible community of small and large chemical businesses, radically changing the view of the chemical industry
V3-Concept: Open Innovation.
V4-Motto: The chemical innovation community.

By Michiel1972 (Own work) (CC BY-SA 3.0), via Wikimedia Commons

functional | physical

Population campus: **1.185** aprox.
P1- Employees: 1.185

Orgs. in campus: **54** est.
E1: 34 companies on Chemelot Campus and 20 companies on Chemelot Industrial Park.

Facilities in campus:

F1 — F1: staff restaurant and auditorium
F2
F3

Population city: **93.914** (CBS, 2013)

Employement city: Not found
Main employers-sector: Industry with 11.191 jobs and Health care sector with 8.995 jobs (Kerncijfers Sittard-Geleen 2011-2012)

3rd education city: **1** university in the region (Maastricht University, R-197) + HEI: 2 in Sittard-Geleen (Fontys School of applied sciences and Hogeschool Zuyd orLeeuwenborgh) and 6 in Maastricht.

Amenities city:

A1: Historic city centre with heritage sites; 2 museums; 10 art galleries; 5 theatres; 2 cinemas; shopping areas
A2: several cafes and restaurants
A3: green areas with an extensive network of hiking, cycling, and mountain biking trails; 2 large parks and other forests in the surroundings; urban gardens; wellness and swimming facilities; sport and recreation centre; 2 large Sports Halls

Ext. Promoters:

Prom 1: The Chemelot Campus Consortium
Prom2: Maastricht Region; Brainport; Maas Valley Frontier (Grensmaasvallei) Westelijke Mijnstreek, the Tourist Office for South Limburg; Limburg Economic Development; Gemeente Sittard-Geleen

Funding campus:

PPP: DSM invested in acquisition and real estate; Sittard-Geleen invested in infrastructure. Chemelot Campus B.V. is established to further develops Chemelot Campus and it is the legal person that gives shape to the Chemelot Campus Consortium. The initiators of this consortium, the Province of Limburg, Maastricht University/ Maastricht UMC+ and DSM, each holding a total of 33.3%.

Controllers campus:

Defined: Chemelot Campus B.V. provides supporting facilities and shared services ('fitting' real estate) for the educational and research activities and the industry at the campus and manages, operates and exploits all the Chemelot buildings.

strategic | financial

Scale campus: **M** (Area in a District)

Land use area: **800 ha**

Density city: **1.217** inh./sq km

Transportation City: Bike infrastructure; national railway; bus network. The city is served by Maastricht Aachen Airport

Distance campus from:

Airport	City centre	University
12 km	6 km	24 km
60'	30'	80'
Maastricht-Airport	Geleen Central Station	Maastricht University

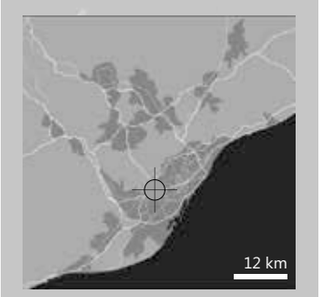
Barcelona City of Knowledge

Barcelona, Catalonia, ES

Contains

Code: **37-BCK**

Year: **2009**



Ext. promoters:

Prom2: The area is adressed several times as a site for business investments in Strategic sectors of the City of Barcelona.

Funding campus:

PPP: BKC is a collective project which aims to strengthen the idea of a participative and cooperative government. The Barcelona City Council, the Chamber of Commerce of Barcelona and the Spanish National Research Council (CSIC) are partners of this project along with the University of Barcelona and the Polytechnic University of Catalonia.

Controllers campus:

Planned: BKC is aimed at a common governance structure through a single committee; a social, business, & scientific council; and a coordination and management unit. A Unit Governance Committee will be created comprising the rectors of the University of Barcelona and the Polytechnic University of Catalonia, the Mayor of Barcelona, the Chairperson of the Barcelona Chamber of Commerce and the Chairperson of the Spanish National Research Council (CSIC).

Vision city: V1-Strategy: Barcelona Vision 2020

V2-Ambition: 'Reinforce its relationships with the emerging cities of the world and hold capitality of the Mediterranean'

V2-Goals: the stimulus of clusters and new transversal growth-driving sectors on a world scale; the creation of new companies and better trained and educated staff; and the revitalisation and updating of traditional industrial capital and local economies of agglomeration.

V3-Concepts: economic and social leadership; competitiveness and sustainability.

Vision campus: V1-Plan: Convertion Plan 2015 - campus model

V2-Ambition: to establish a framework for strategic collaboration aimed at building a knowledge ecosystem to promote employability, social cohesion and territorial economic development.

V2-Goals: be an international benchmark in teaching, research, knowledge transfer,innovation, and lifelong learning; attracting and encouraging talent, based on full internationalization; developing a comprehensive model of campus committed to the environment in a sustainable manner and student-oriented.

Google Earth, 2016

Official denomination:

In transition: regarded as City of Knowledge, Gateway of knowledge and Territorial campus.

Barcelona City of Knowledge or 'Gateway to Knowledge' is a project regarded as one of the most active scientific, technical and economic hubs in the country. This zone encompasses a number of physical clusters of knowledge activity including the Diagonal Campus of the University of Barcelona, the North and South campuses of the Polytechnic university of Catalonia (UPC) established in the area since 1980, the Technology Park of Barcelona, the institutes of the Spanish Council for Scientific Research (CSIC), the Advanced School of Business Administration and Management and the Faculty of Law ESADE – part of the Ramon Llull University– and the Hospital de Sant Joan de Déu, among others.

financial | strategic

Scale campus: **M** (Area in a District)

Land use area: **227 ha**

Density city: **15.813** inh./sq km (2011)

Transportation City: Regional and metropolitan (underground) railway network; buses lines; taxis, funicular; trams. Served by Barcelona-El Prat Airport and the Port of Barcelona

Distance campus to:

12 km	7,5 km	≤1 km
40'	30'	≤15
Barcelona-El Prat Airport	Estació del Nord	University of Barcelona and UPC
Airport	City centre	University

physical | functional

Population campus: **54.750** aprox.

P1-Employees: 3.700 academic staff ; 2.250 administrative and service staff

P2-Students: 42.000 students and 6.800 researchers and postgraduate students

Orgs. in campus: **73** aprox.

O1: >70 companies in Barcelona Science Park in (1997)

E2: 2 universities

E3: 3 research institutes

Facilities in campus:

F1

F2

F3

F3: housing for students & guests

Population city: **1.615.448** (Census 2011)

Employment city: **853.132** (2001)

Main employers-sector: Service with 747.943 workers or 87,7% of employement (2001)

Tertiary education city: **8** universities (University of Barcelona; Autonomous University of Barcelona; Polytechnic University of Catalonia; Pompeu Fabra University, R-186; Ramon Llull University; University of Catalonia; International University of Catalonia; Abat Oliva CEU university)

Amenities city:

A1

A2

A3

A1: 37 libraries; >20 Museums, collections, and exhibition centers; 203 commercial cinemas rooms; >50 Theatres and other places of performing arts; 3 large music auditoriums

A2:several shops and commercial districts

A3: >1.700 Sport facilities; 559 Urban parks; 10.981.127m2 of urban green area

Cluster base campus:

SciResearch: Life sciences, social sciences and technologies. BKC also covers other thematic areas following the same standards of excellence: architecture, engineering, sciences and Fine arts.

Economic base city:

Consolidated: service sectors (87% of jobs); Industry (8,8% of jobs) and Construction (3,5% of jobs) (2011)

Key sectors: knowledge-intensive sectors: information and communication technology (ICT), media, biotechnology and life sciences, energy, design, sustainable mobility and aeronautics, agrofood, etc.

GIANT Innovation Campus (Grenoble Innovation for Advanced New Technologies)

Grenoble, Isère, Rhône-Alpes, FR

Touches
Contains

Code: **38-GIANT**

Year: **2009**

Official denomination:

Permanent: as Campus

GIANT is located in Grenoble, at the heart of the French Alps. Spatially, the campus is divided into three technological districts supported by three so-called cross-competence centres. Technological districts are: Information and Communication; Energy; and Healthcare. GIANT's development plan embodies a radically new carbon-neutral approach, underpinned by three key principles: cooperative energy management; a combined transport system; and integrated urban blocks. Grenoble has been regarded as one of the most innovative territories of France with its development model built on a historic partnership between academia, research and industry.

Cluster base campus:

SciResearch+R&D: Communication technologies; Renewenable energies and environmental problems; Bioscience and healthcare

Economic base city:

Emergent & Key sectors: three growth sectors: Micro-nanotechnologies and software; Biotechnology and Life Sciences; New energy technologies. Grenoble is also a rich diversified industrial fabric where traditional sectors (mechanical, chemical) still play an important role in the economic fabric and local employment.

Vision city:

V1-Policy: national industrial policy (2004) to mobilize the key competitiveness factors as the ability to innovate.
V1-Plan: 'Grenoble Factor 4' for an inclusive and sustainable city (City Council, 2008)
V2-Ambition: Support for competitiveness clusters is a priority for the City of Grenoble which financially supports research and development worn by actors in Grenoble poles, mainly SMEs and laboratories
V2-Goal: fourfold emissions greenhouse gas emissions by 2050.

Vision campus:

V2-Ambition: Companies, researchers and students working together to drive innovation.
V2-Goals: to address the major societal challenge on Information and communication, energy, healthcare; To decompartmentalise and create technological districts and centres of excellence focused on key application areas; To harmonise urban and scientific development.
V3-Concept: the GIANT partners, together with their regional and national authorities, have launched a major urban transformation of the campus to shape it into a vibrant and attractive urban district.
V4-Motto: GIANT The Campus of Technological Innovation.

By Christian Hendrich, 2004 (CC BY-SA 3.0), via Wikimedia Commons

Ext. Promoters:

Prom2: GIANT partners include research organisations, local authorities, players in higher education and industry whose academic and economic goals are aligned with its approach. Local governments partners are: Etat; Région Rhône Alpes; Département de l'Isère; la Métro - Communauté d'agglomération; Ville de Grenoble

Funding campus:

Public & Private: Public & Private: Founding members include three in university sector (Grenoble ecole de Management (GeM); Institut Polytechnique de Grenoble (Grenoble InP); Université Joseph Fourier (UJF)); two major French research institutions and three leading european laboratories. An investment of 1.3 billion Euro was launched by architect Claude Vasconi for urban development.

Controllers campus:

Defined: GIANT partnership is addressed as the management body controlling the campus. Nevertheless, information about this entity and its organisation structure was not found.

functional | physical

Population campus: **16.000** aprox.* (*excluding residents)

P1 Employees: 6.000 researchers; 5.000 industrial jobs
P2-Students: 5.000
Planned Residents: 30.000 (10.000 researchers; 10.000 industrial jobs; 10.000 students; 10.000 residents)

Orgs. in campus: **48** est.

O1: 40 companies;
O2: Grenoble Ecole de Management; 5 schools of Grenoble Institute of Technology and schools of Joseph Fourier University in MINATEC clusters
O3: 3 centres; 2 research Institutes

Facilities in campus:

F1
F2
F3

F1: restaurants, leisure facilities
F2: parks and abundant green spaces
F3: housing

Population city: **156.000** (Grenoble, 2013)

Employement city: **166.000** (2012)
Main employers-sector: 36% in Services and 23% in Industry (CCI Grenoble, 2012)

3rd education city: **4** universities
HEI: 9 grandes écoles.

Amenities city:

A1
A2
A3

A1: 17 museums; 6 dance theatres; 15 music stages; 13 theatres; 9 cinemas; 19 libraries; 3 major congress facilities; many historical sites and architectural heritage
A2: streets with commercial sites;>15 traditional markets
A3:>50 parks and gardens; 3 natural parks in the surroundings;
several squares

strategic | financial

Scale campus: **M** (Area in a District)

Land use area: **250 ha**

Density city: **8.496** inh./sq km

Transportation City: Served by Grenoble-Isère Airport, Lyon Saint-Exupéry Airport and Geneva International Airport; Metyrovelo (bike rents); bus and tram lines; the campus is accessed through railway network - high speed trians (TGV).

Distance campus from:

Airport	City centre	University
40 km	1,5 km	≤1 km
50'	5-15'	≤15'
Grenoble-Isère Airport	Gare de Grenoble	Grenoble Ecole de Management & Grenoble Institute of Technology

RWTH Aachen University & Research Campus Metalen

Aachen, North Rhine-Westphalia, DE

Disjoints

Code: **39-RWTH-RCM**

Year: **2011**

Official denomination:

Permanent: as Campus

Ext. promoters:

Prom1:The city of Aachen and RWTH Aachen University.

Vision city:

V1-Strategy: Aachen Mission 2020s aligned to strenght collaboration.
V3-Concept: Aachen. Knowledge creates the future the profile of the Science and Technology Region Aachen is outlined. In 2013, Aachen is a recognized center of knowledge and technology region.
V-4 Motto: 'Aachen, we all are'

Funding campus:

Public: The expansion areas of the RWTH Aachen Campus are owned by the Bau- und Liegenschaftsbetrieb NRW (BLB NRW) which is a building and real estate management authority owned by the State of North Rhine-Westphalia.

Vision campus:

V4-Motto institution: Excellence through achievement.

Controllers campus:

Defined: RWTH Aachen Campus GmbH (Campus GmbH) is responsible for the development, planning, realisation and safeguarding of the overall campus concept. RWTH Aachen Campus GmbH was founded specifically to assume the management of the RWTH Aachen Campus. As a joint subsidiary of RWTH Aachen University (95%) and the City of Aachen (5%) it coordinates all activities relating to RWTH Aachen Campus and represents the interests of all key stakeholder groups, both internally and externally. RWTH Aachen Campus GmbH has the exclusive right to decide on the utilization of the new campus premises as the contracting authority.

Google Earth, 2016

financial | strategic

Scale campus: **S** (Portfolio in an Area)

Land use area: **47,3 ha**

Density city: **1.541** inh /sq km (estimated)

Transportation City: Bus and railway (Euroregio train and 2 HSL; Thalys and ICE) networks. The nearest airports are Düsseldorf International Airport, Cologne Bonn Airport and across the border in the Netherlands, the regional Maastricht Aachen Airport.

Distance campus to:

Airport	City centre	University
35 km	5 km	≤1 km
120'	30'	≤15'
Maastricht Aachen Airport	Aachen Hauptbahnhof	RWTH Aachen

physical | functional

Population campus: Not found

P1-Employees:120 aprox.
P-2 Students: Not found
Plans: 11.000 employees expected

Orgs. in campus: Not found*

*In 2011, 81 firms are matriculated from the 100 expected; 31 departments from the RWTH and one department from the FH Aachen, have already committed themselves to a long-term cooperation and to relocate to the RWTH Campus in Melaten.

Facilities in campus:

F1 F-Plan: hotels and restaurants, shops and services.

F2

F3

Population city: **248.137** (2012)

Employment city: **110.114** (employed with social security)
Main employers-sector: the Service sector employs 90.293

Tertiary education city:

4 HEIs (including RWTH Aachen, R-168)

Amenities city:

A1: 1 International School; 6 theatre, concert halls and 8 museums; numerous castles, fountains and springs

A2: several restaurants, caf'es pubs, and bar gardens

A3: 230 sport clubs; 35 sports grounds, 75 indoor sports centres and 14 gymnasiums; large wooded area in the surrounding.

RWTH Aachen, aims at becoming one of the leading technical universities worldwide with the new RWTH Aachen Campus. Campus Melaten is in the first phase of construction for RWTH's new research park which overall is planned to accommodate 19 research clusters over a 800,000 m² site. Within the next 6-8 years, up to 150 national and international companies with direct connections to institutes and research centers are expected to settle in a mixed functional area. A resolution for the development plan was then passed on December 16, 2009. The first phase of construction for the first six research clusters on Campus Melaten is to take place from 2011-2012 (Based on Van Winden, 2011)

Cluster base campus:

R&D: The initial six clusters include Logistics, Integrative Production Technology, Photonics, Bio-Medical Engineering, Heavy Duty Drive Systems and Components, and Eco-friendly Sustainable Energy.

Economic base city:

Key sectors: Automotive and Rail Technology; Chemical Industry; Electronic & optical industry; energy & climate protection; Healthcare; Forest & Wood; ICT; Life Sciences and Medical Technology; Logistics; Mechanical Engineering and Industrial Engineering; Modern Materials and Plastics; Food; Paper and specialised supply industries; Textile technology.

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28-BAHU Berlin Adlershof Humboldt University Berlin, Brandenburg, DE
Empirical research:
- The Campus & the City (Christiaanse & Hoeger, 2007)

Websites:
- http://www.adlershof.de/en/homepage/
- http://www.berlin.de/berlin-im-ueberblick/zahlenfakten/index.en.html
- http://www.visitberlin.de/en/article/facts-and-figures
- http://www.businesslocationcenter.de/en/business-location/labor-market/workforce-potential/employed
- https://www.berlin.de/sen/wirtschaft/politik/innovationsstrategie.en.html

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29-SHIP Shenzhen Hi-Tech Industrial Park Shenzhen, CN
Empirical research:
- Site planning and guiding principles of hi-tech parks in China: Shenzhen as a case study (Fang, C.a , Xie, Y., 2008)

Websites:
- http://english.sz.gov.cn/iis/iis3/
- http://en.szinvest.gov.cn/Publications_Industry.asp
- http://www.china.com.cn/market/zhuanti/402531.htm

Online documents:
- http://en.szinvest.gov.cn/pageimage/InvestmentGuide.pdf

Photo: By Brücke-Osteuropa (Own work) [Public domain], via Wikimedia Commons, https://commons.wikimedia.org/wiki/File%3AZTE_Shenzhen.JPG

30-TSP Tainan Science Park Tainan City, TW
Empirical research:
- Half-transformed: Tainan county after the Science Park (Review)(Crook, S, 2007);
- The interactive relationships and development effects among the KIBS firms and their clients in Taiwan: A comparative study (Lee, Y.-K., Hu, T.-S. , Chang, S.-L., Chia, P.-C., Lo, H.-M, 2012)

Websites:
- http://www.stsipa.gov.tw/web/indexGroups?frontTarget=ENGLISH
- http://foreigner.tainan.gov.tw/en/
- http://web1.tainan.gov.tw/InvestInTainan_eng/CP/11703/environment.aspx

Online documents:
- http://www.sipa.gov.tw/english/file/20130412110153.pdf

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31-HTCE High-Tech Campus Eindhoven Eindhoven, North Brabant, NL
Empirical research:
- Van der Borgh, Michel, Cloodt, Myriam, & Romme, A Georges L. (2012). Value creation by knowledge-based ecosystems: evidence from a field study. R&D Management, 42(2), 150-169.
- Hoeger, Kerstin, & Christiaanse, Kees. (2007). Campus and the City - Urban Design for the Knowledge Society (K.

Hoeger & K. Christiaanse Eds.). Zürich: gta Verlag.
Websites:
- http://www.hightechcampus.com/about_the_campus/
- http://www.sre.nl/english/the-cityregion-eindhoven-sreSRE: Samenwerkingsverband Regio Eindhoven
- http://www.eindhoven.eu/en/Introduction/Introducing_Eindhoven/Facts_%26_Figures
- http://www.brainport.nl/en/brainport-2020

Photo: http://www.microtoerisme.nl [CC BY-SA 3.0 (http://creativecommons.org/licenses/by-sa/3.0)], via Wikimedia Commons, https://commons.wikimedia.org/wiki/File%3A1302_Eindhoven_-_HTC_064.jpg

32-SPA Science Park Amsterdam Amsterdam, North Holland, NL
Empirical research:
- The Campus & the City (Christiaanse & Hoeger, 2007);
- Managing the University campus [Den Heijer, 2010]

Websites:
- http://www.scienceparkamsterdam.nl/
- http://www.os.amsterdam.nl/feitenencijfers/amsterdam/
- http://www.iamsterdam.com/en-GB/business/About-the-Amsterdam-Economic-Board

Online documents:
- The Science Park Amsterdam http://www.watergraafsmeer.org/images/sitedocuments/partners/universiteit_utrecht/case%209%20-updated.pdf
- http://www.scienceparkamsterdam.nl/fileadmin/site/dokumenten/SPA_bidbook_EN.pdf

Photo: By Jvhertum (Own work) [CC BY-SA 3.0 (http://creativecommons.org/licenses/by-sa/3.0)], via Wikimedia Commons, https://commons.wikimedia.org/wiki/File%3AAmsterdam_science_park.jpg

33-BPS Biopolis Singapore City-State, SG
Empirical research:
- Singapore Biopolis: Bare Life in the City-State (Waldby, C. 2009);
- Singapore: Building a biopolis (Short Survey)(Cyranoski, D. 2001);
- Singapore: filling biopolis. (Smaglik, P. 2003)
- Singapore to open fusionopolis (Review) Yarbrough, C. 2008

Websites:
- http://www.nature.com/nature/journal/v425/n6959/full/nj6959-746a.html http://www.jtc.gov.sg/RealEstateSolutions/one-north/Pages/Fusionopolis.aspx
- http://www.a-star.edu.sg/?tabid=860
- http://www.jtc.gov.sg/Industries/Biomedical/Biopolis/Pages/Biopolis-Development.aspx

Photo: By Henry Leong Him Woh. (The Singapore Biopolis - (A*STAR) One-North.) [CC BY-SA 2.0 (http://creativecommons.org/licenses/by-sa/2.0)], via Wikimedia Commons, https://commons.wikimedia.org/wiki/File%3ABiopolis-Singapore-20080712.jpg

34-TCSP Taichung Science Park Taichung,Central Taiwan, TW
Empirical research:
- The integrated spatial planning for Taichung Science Park community and leisure development (Conference Paper) (Hsieh, C.-C., 2011)

Websites:
- http://eng.taichung.gov.tw/siteOld/english.taichung.gov.tw/internet/english/docDetail1827.html?uid=4149
- http://investtaiwan.nat.gov.tw/eng/show.jsp?ID=325

Online documents:
- http://www.sipa.gov.tw/english/file/20130412110153.pdf
- http://www.ctsp.gov.tw/files/e77a2d5c-eb75-43bf-856f-56216beaa89c.pdf

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35-BP Biocant Park Cantanhede, Coimbra, PT
Empirical research:
- Knowledge Locations (Carvalho, 2013)

Websites:
- www.biocant.pt
- http://www.cm-cantanhede.pt/mcsite/Content/?MID=2&ID=519&MIID=226

36-CRDP Chemelot Campus Sittard-Geleen, Limburg, NL
Websites:
- www.chemelot.nl
- http://www.insittardgeleen.nl/nl-nl/5/126/cijfers-feiten.aspx
- http://sittard.amuseerje.nl/theater

Photo: By Michiel1972 (Own work) [CC BY-SA 3.0 (http://creativecommons.org/licenses/by-sa/3.0) or GFDL (http://www.gnu.org/copyleft/fdl.html)], via Wikimedia Commons, https://commons.wikimedia.org/wiki/File%3AChemelot.jpg

37-BCK Barcelona City of Knowledge Barcelona, Catalonia, ES
Empirical research:
- The Campus & the City (Christiaanse & Hoeger, 2007)

Websites:
- http://www.pcb.ub.edu/
- http://pinnova.upc.es/BKC/index.php?cont=campus
- http://www.bcn.cat/estadistica/angles/dades/anuari/index.htm
- http://w42.bcn.cat/web/en/per-que-barcelona/sectors-estrategics/index.jsp

Online documents:
- http://www.pemb.cat/wp-content/uploads/2011/07/PEMB-2020-angles-WEB.pdf
- http://pinnova.upc.es/BKC/pdf/Descripcion_del_proyecto_english.pdf

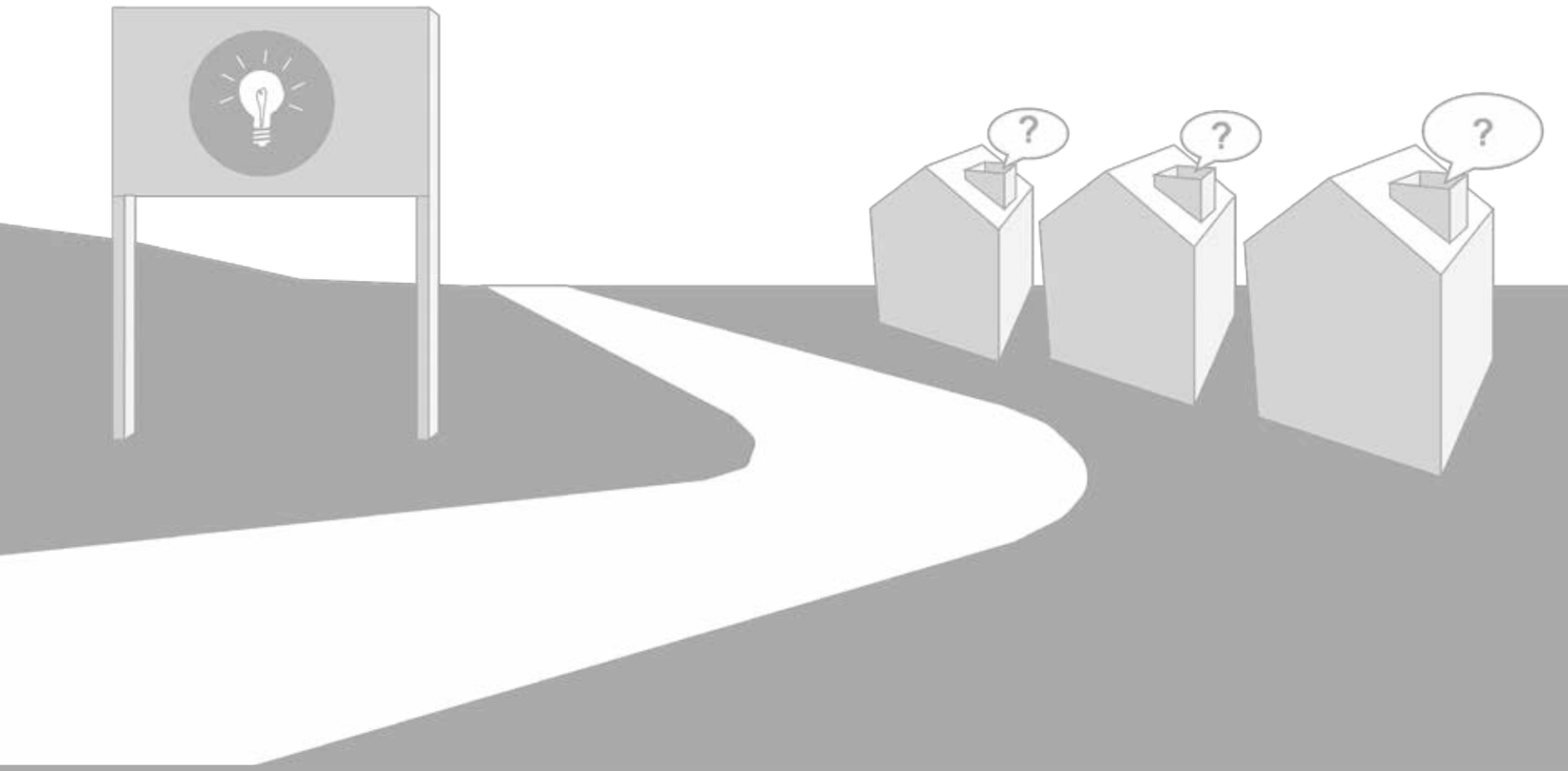
38-GIANT GIANT Innovation Campus [Grenoble Innovation for Advanced New Technologies] Grenoble, Isère, Rhône-Alpes, FR
Websites:
- http://www.giant-grenoble.org/en
- http://www.grenoble.fr/93-l-economie-grenobloise.htm

Online documents:
- http://www.grenoble.cci.fr/medias/fichier/presentation-economie-octobre-2012-nouveau-logo_1352191238589.pdf
- http://www.giant-grenoble.org/images/giant_brochure_en.pdf

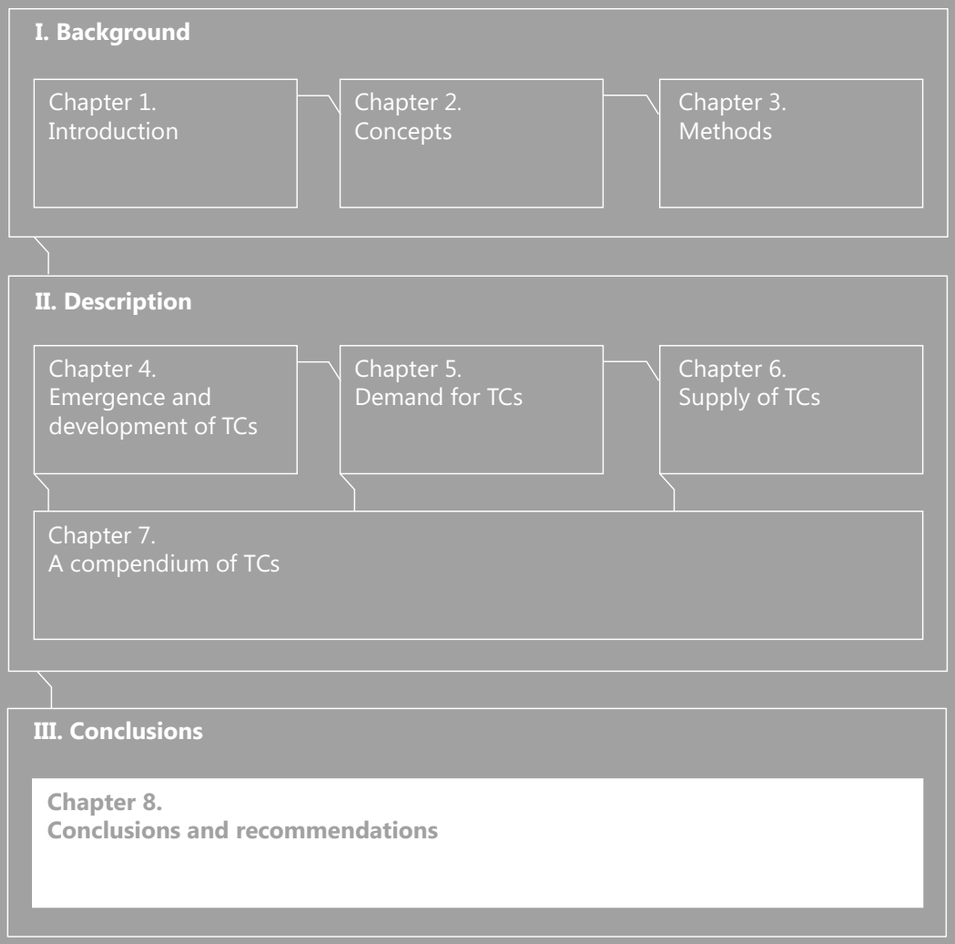
Photo: Christian Hendrich 2004, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=232491

39-RWTH-RCM RWTH Aachen University -Research Campus Metalen [expansion] Aachen, North Rhine-Westphalia, DE
Empirical research:
- Knowledge Hotspots (Willem van Winden, 2011)

Websites:
- http://www.rwth-aachen.de/go/id/ekt/lidx/1
- http://www.aachen.de/DE/stadt_buerger/aachen_profil/statistische_daten/bevoelkerungsstand/index.html
- http://www.agit.de/en/region-of-technology/overview/the-technology-region-aachen-in-detail.html
- http://www.aachen.de/EN/kf/freizeit_en/index.html



C. Conclusions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8. Conclusions and recommendations

This chapter draws the conclusions of this study by answering its main question: What are the distinct characteristics of technology campuses from the built environment perspective? Next, it reflects on the quality of the study and its limitations. Finally, it addresses how its findings can be used further in research and practice.

8.1. Technology campuses as built environments

Until now, technology campuses have remained roughly unexplored from its physical dimension. This study provides a comprehensive overview of technology campuses, showing that built environments with particular characteristics (in terms of demand and supply) have shaped the concentration of research activities in different locations around the world.

On the one hand, the demand for technology campuses is characterised by the explicit intention to concentrate research activities in a single location in a deliberated manner. Universities, R&D firms, research institutes and governments are the main stakeholders involved in the development of technology campuses as founders, managers and promoters of these built environments. These stakeholders share the demand for developing real estate with the aims to stimulate innovation and to encourage economic development. The identification of 12 main goals among the 39 cases confirms this alignment in ambitions. For instance, 'Encouraging innovation for economic growth and development' is the most popular goal among technology campuses (64% of the sample address this goal). Besides, 'Encouraging academia, science and R&D for economic growth' is the most popular goals addressed both in campuses and the cities (87% of the sample). This demand emerged and developed during critical periods of technological advancements during the 20th century: (1) the post-war period or atomic age (9% of the sample), (2) the space age and ICT industrial revolution (41% of the sample) and (3) the digital and information age (40% of the sample). Nowadays, most of these built environments accommodate multiple organisations that perform research activities in a broad range of technology fields to support different core businesses. The most common fields related to research activities in the 39 campuses and their cities are biotechnology, information sciences, energy, materials and engineering.

On the other hand, the supply of technology campuses is more heterogeneous because it is described through various characteristics. Empirical evidence supported the existence of differences but also marked similarities describing the supply of technology campuses regarding location, layout, size, density, and block pattern. The four characteristics emerging from the empirical data are interrelated and altogether can be used to describe the supply of technology campuses as follows:

- **The location** shows most technology campuses (1) are found in industrialised regions: 54% in Europe and 10% in North America; (2) they have a border condition regardless its relation with the hosting city (87% of the sample); and (3) are near to (or in) universities' locations: 56% of the sample is within 15 minutes by foot and 71% of the sample is within 30 minutes by public transport. Similarly, the analysis of this characteristic shows 5 different relationships between campuses and their hosting cities/regions (Equals 8%, Contains 28%, Overlaps 13%, Touches 36% and Disjoints 15%). These relationships are associated with specific spatial dynamics in their contexts showing most campuses are in transition due to urbanisations processes (77% of the sample in the categories Contains, Overlaps and Touches).
- **The layout** emphasises the clustered character of technology campuses as built environments, which is dominated by compact and practical arrangements in their designs (46% of the sample). Nevertheless, the study of this characteristic also shows that although practical arrangement is very common in the design of campuses (71% of the sample)many campuses are also dispersed due to their large size (38% of the sample).
- **The size and the density** show technology campuses occupy large pieces of land intended to accommodate large populations in cities/regions. Together, technology campuses occupy 69.600 hectares (1.800 hectares on average). However, there are marked differences in their physical size (the surface of technology campuses ranges from 28 up to 23.800 hectares. The latter is Kansai Science City, an unincorporated city between three prefectures in Japan). In terms of users, the size of technology campuses is equally diverse. Together, they have 1,3 million users (3.700 users on average). However, the users' range is wide (between 210 and 238.000 users). Not surprisingly, the largest campuses in size and users are those considered as Equals (i.e. the campus is the same as the city). When looking at the density, one can say technology campuses have a relatively low density (99,5 users per hectare on average). The densest campus has 438 users per hectare while the least dense campus has one user per hectare.
- **The block pattern** shows that all technology campuses are designed and built with the idea of self-standing buildings on the ground as predominant building unit. The analysis shows an association between these patterns influencing planning principles of modern architecture during the 20th century. Examples of these principles are deliberated the use of orthogonal configurations (21 cases), grid-shaped blocks (14 cases), closed road networks (19 cases) and invisible superblocks (8 cases).

This research indicates that some of these characteristics are the result of explicit intentions of planners and designers. For instance, in some cases, the layout, size and block pattern characteristics suggest the influence of modern and contemporary urban planning principles, which became popular by the time these built environments have been developed (e.g. self-standing buildings on the green, large and open spaces outside cities to be accessed by car). These findings emphasise the character of these built environments as preconceived or ideal models envisioned as part of comprehensive plans influenced by multiple stakeholders. Their intentions to concentrate research activities in one place are translated into design and planning principles that gave shape to an archetype that has been replicated -with slight variations- in many places up today.

The most significant variation is revealed in the location characteristic. Particularly, this study paid attention to the five types of relationships observed between the campuses and its hosting cities/regions. These relationships range from the inner city up to peripheral locations and are determined by the physical and functional integration of the campus with its hosting city/region. In turn, there is a persistent isolation condition in most of the campuses surveyed regardless the different location characteristics. For instance, campuses are archetypes recognisable as distinct and sometimes independent built environments in their spatial contexts. These observations suggested that the intentions influencing location decisions are far more complex and context specific. These findings made location an even more interesting aspect to address the relationship between the built environment and innovation, especially in the dynamic context of the knowledge economy.

8.2. Limitations

The use of unconventional methods supposed methodological challenges causing some research limitations. For instance, the qualitative survey is rather an unfamiliar method in social research methods compared with the well-known statistical survey (Jansen, 2010). The survey used in this research studies the diversity (not the distribution) of a population with the purpose of description. Since campuses are the subjects under examination, this qualitative survey uses documentation analysis rather than questionnaires for data collection. This means this study is documented through multiple and open sources of data collection (e.g. academic and non-academic sources).

The broad range of built environments technology campuses entails (being rather an unfamiliar topic) made difficult to narrow down the focus of the research. Similarly, the vast amount of data collected from different sources and in different contexts supposed limitations for comparison in a reduced time. The consistency of this data was audited through the design of a protocol that developed and expanded iteratively with the simultaneous insights from theory and empiric. This flexibility in the protocol strengthened the richness of the data collected while at the same time supposed limitations concerning complexity experienced during its analysis. Overall, revisiting and redefining the guiding questions helped to prioritise and select the relevant sources and data analysed in this research.

The empirical data collected in this research is presented in a compendium that describes technology campuses in a systematic way that allows comparison and replication. Although most of the data was collected in 2013, this information can be updated and the indicators used to describe campuses as built environments can be used to compare these and similar built environments.

8.3. Further research

The description of technology campuses as built environments provides an empirical ground to develop further research and examine its subject of study from a development perspective. To begin with, the research presented in this book has served as the empirical ground of a doctoral thesis entitled 'Technology campuses and Cities: A study on the relation between innovation and the built environment at the urban level' (Curvelo Magdaniel, 2016). Similarly, these findings can be useful to other researchers in the fields of real estate management, urban development management, architecture and urbanism investigating these and similar areas in the context of the knowledge economy. The following are addressed as relevant avenues for research.

8.3.1. Innovation, cities and campus governance

This study identifies 'stimulating innovation' through campus development as one area of alignment between government, firms, and universities. These organisations often look at innovation through different lenses, but they also share mutual goals. Indeed, the developments of technology campuses can be seen as living-labs to address collaborative societal challenges led by these organisational spheres.

Knowledge is a source of urban competitiveness in the current economy. The ideal city in the knowledge economy is an 'attractive, inclusive, networking and open city' which is characterised by the concentration of human capital and the organisation of this capacity into productive outcomes. Attaining these attributes requires the collective action of the already mentioned organisations, which collide during different stages of campus development. Campuses are living laboratories to explore potential solutions to the urbanisation challenge society is facing. They can be seen as both, smaller prototypes of cities and 'the city'. Campus development is an exemplar case of new practices of urban governance. For instance, attracting students and retaining them as future knowledge workers and entrepreneurs in cities has become a shared goal of universities, firms and local governments. They are organising their capacities to attain this goal, which benefits them in different ways because attracting and retaining talented people can lead to positive economic, social, and spatial effects in cities.

The contemporary view of knowledge as the driver of the current economies might lead the shift to the next economies, in which skilled people will strengthen their current position as the most valuable assets of the future cities. There are already exemplar practices of the collective action of organisations using the political 'innovation discourse' that lies at competitiveness when adapting to the dynamic urban transformation of areas towards more attractive, inclusive, sustainable and well-connected cities. Different local actors are collectively working on adapting and re-using the heritage and industrial infrastructure in abandoned or vacant urban areas to accommodate offices and housing tailored to the flexible demands of students and young entrepreneurs. Implementing this has required political, planning and design interventions. Simultaneously, these areas can function as laboratories for testing new green technologies both, at building and area level using citizens' feedback. The role of the public space gains momentum by adding to the urban biodiversity, creating civic places around public amenities, and strengthening walk-ability and transit-oriented development.

Many university- and corporate campuses around the world have already started these types of interventions reaching a level of organisational and spatial integration required to address the urbanisation challenges of future cities. Most campuses have this potential but also pose issues that can be tackled by learning from context-specific experiences. Cities can be envisioned by using campuses as test beds to involve, engage and empower citizens through the urban transformation. Understanding how campuses may help cities and organisations to attain they shared goals is a future area for research.

8.3.2. Campus locations and the urban transformation

This study provided empirical evidence that depict thirty-nine technology campuses as the products of preconceived and idealistic planning models, which are currently in transition. The location patterns outlined that most campuses have an isolated condition. For instance, many of them were built outside the city reproducing the Greenfield campus model. However, some of them are already in- or at the edge of the city due to distinct or combined urbanisation processes (e.g. cities have grew and expanded to their peripheries, other organisations have settled in the peripheries of these campuses, or the combination of both processes). Certainly, these campuses and their hosting cities develop separately. Many campuses were built from scratch as preconceived models with their own internal structure. This view is emphasized in terms of layout characteristics. For instance, most technology campuses have a compact and practical layout regarding their spatial and practical organisation, in which their buildings are deliberately arranged in a certain way in response to a plan and a program. Overall, their functional and spatial configurations are different from those of the cities surrounding them but less independent with the dynamic urban transformation. The different relationships between the campus and the city revealed in this study indicate that campus development is a dynamic process. These relationships are likely to change with particular developments in each campus context.

The dynamic view of campus development as part of a wide social and spatial context demands flexibility in campus management and planning to adapt to the changing requirements of such contexts. Furthermore, it calls for refreshing the current views on campus design. The campus as a collection of buildings in defined grounds has been established as the archetype to concentrate research activities. However, replicating today campus models from the 1950s, just because they have evolved at a successful development, is a controversial approach to steer the built environment as a resource to stimulate innovation. Essentially, the Greenfield campus is an ideal model matching the demands of the 20th century, which was the contested answer to the problems of the industrial city. The spatial and economic conditions that influenced campus developments then, were different than the ones society is facing now and will face in the future. The ways of doing research and the profile of the researchers –so-called knowledge workers- have changed with advancement of technology and globalisation. People and organisations' needs, routines and preferences have rapidly changed over the last decades, especially with the technological advancements of the digital and information age. Organisations spent many resources trying to fit their changing demands into their existing and aging buildings via transformation, interior adaptation, and public space interventions. This study illustrates that campuses have not changed much in the last fifty years. This knowledge makes room for debating the replication approach in the practice of campus development with the aim to stimulate innovation. Disregarding the dynamic context in which tech-based research activities are accommodated can lead to inefficient ways to spend resources.

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Appendix A

Campus management research

Over the past twenty years, the department of Management and the Built Environment has made a significant contribution to building a body of knowledge on the management of the campuses of universities. The research has contributed to existing theories on real estate management and built new theory. The objective of research has always been to provide tools and information for practice. As such, researching campus management has been at the core of the department's research on corporate real estate management, exceeding financial and business economics goals and incorporating societal and institutional goals in the decision-making process.

The first phase of the campus research, up to the publication of the dissertation 'Managing the University Campus', can be characterized as building standards for campus management: by describing the position of campus management (in real estate management theory), its purpose (adding value), the management process of adding value (matching supply and demand, now and in the future) and the available tools per step of the management process (campus and project benchmarks, scenarios, etc.). The current and future research projects are aimed both at further research based on these standards -applied to the European campus and Campus NL- and further research into more specific aspects of campus management. This can be related to a specific type of real estate (learning spaces, technology campuses or the academic workplace), to a specific stakeholder perspective (sustainability) or to the development of more tools for specific parts of the management process (smart tools on campus or new methods for decision-making). Knowledge and tools will be developed in close collaboration with and for universities.

Key publications

Den Heijer, (2011) Managing the University Campus – Information to support real estate decisions. PhD thesis. Eburon Academic Publishers

Den Heijer, De Vries, De Jonge (2011) "Developing knowledge cities" in Van Geenhuizen, Marina and Peter Nijkamp, Creative knowledge cities, Edward Elgar, February 2012.

Den Heijer and Curvelo Magdaniel (2012) The university campus as a knowledge city: exploring models and strategic choices. International Journal of Knowledge- Based Development, 3(3), 283-304.

Den Heijer and Tzovlas (2014) The European Campus - Heritage and Challenges. Arkesteijn, Valks, Binnekamp, Barendse, De Jonge (2015) Designing a Preferencebased Accommodation Strategy: a pilot study at Delft University of Technology. Journal of Corporate Real Estate 17 (2)

Curvelo Magdaniel (2016) Technology campuses and cities, a study on the relation between innovation and the built environment at the urban area level. PhD Thesis TU Delft.

Valks, Arkesteijn, Den Heijer, Vande Putte (2016) Smart campus tools: a study on measuring real use of campus facilities (research project for FM departments of 14 Dutch universities)

TU Delft (2016), "Campus NL – Investeren in de toekomst" (boek/rapport in opdracht van VSNU en 14 universiteiten), Delft: TU Delft, Faculteit Bouwkunde, afdeling Management in the Built Environment (MBE), december 2016.

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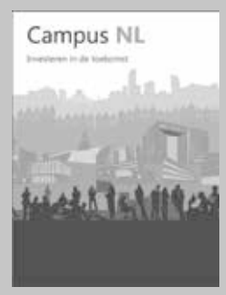
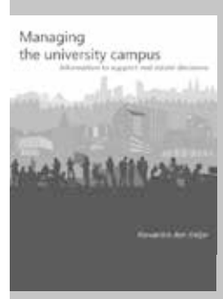
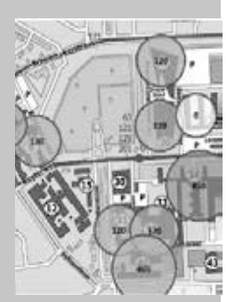






Managing the University Campus
Information to support real estate decisions

Key researchers:
Dr. ir. Alexandra den Heijer

Supervision:
Prof. dr. ir. Hugo Priemus
Dr. ir. Theo van der Voordt

In collaboration with:
14 Dutch universities

Research period:
Jan 2005 - March 2011

The 2011 book/dissertation "Managing the university campus" summarizes the results of ten years of research on a wide range of topics on campus management: from generating references for planning purposes – like current replacement costs and new space standards for the changing academic workplace – to strategies for the sustainable campus and new models that merge the campus and the knowledge city. The book includes profiles of fourteen Dutch campuses and forty campus projects to illustrate trends. The content of this book combines insights from theory – adding to new real estate management theories and the required management information for real estate decisions – and lessons for practice. The book can support the decisions of policy makers, architects, campus and facility managers about the campus of the future.

Research question:
How can universities improve strategic campus management, adding value to the university's performance, conducting which management tasks and using what information and tools?

Deliverables:
This research provided a range of conceptual models, tools and databases to support campus management by identifying and connecting:

- the four main management tasks of campus management: assessing the current campus, exploring changing demand, generating future models and defining projects to transform the campus;
- the four stakeholder perspectives that need to be identified and connected in campus decisions: strategic, functional, financial and physical and the matching variables: goals, users, euros and m2;
- and the three relevant levels for campus decisions - campus in city, building on campus, function in building.

Management information is supplied for key performance indicators (KPIs) that are derived from the performance criteria productivity, profitability, competitive advantage and sustainable development, adding value to the university's current and future performance.

Methods:
Literature search, collective campus data to generate management information for individual universities

Key publications:

Den Heijer, A. (2011). Managing the university campus. Delft: Eburon Academic Publishers.

Den Heijer, De Vries, De Jonge (2011) "Developing knowledge cities" in Van Geenhuizen, Marina and Peter Nijkamp, Creative knowledge cities, Edward Elgar, February 2012.

The European Campus
Heritage and Challenges

The quality of European universities and their campuses not only affects policy agendas of education, research and innovation; it also affects Europe's position in the global competition for the best students and professors. While many European universities still have the heritage and inner-city locations – highlighting the culture and history of Europe – they are also confronted with dysfunctional and energy-inefficient buildings that need reinvestment. Their collective campus decisions influence the competitive advantage, productivity, profitability and sustainable development of Europe.

This book contains data of all 28 European Union member states and draws conclusions about the current state of the European campus, highlighting both the heritage and challenges on campus. The target group of our book is decision makers about the campus, from the European Commission and national governments (setting higher education and innovation goals, allocating resources) to policy makers at European universities.

Research question:
What is the current state of the European campus and how might this influence the Europe 2020 strategy?

Deliverables:

- Database with campus management information across 28 EU member states.
- Recommendations for campus managers. Results are discussed by outlining the campus is paradoxically perceived as both, an enabler and disabler for Europe 2020 strategy.

Methods:
This research collects key performance indicators (KPIs) on strategic, financial, functional and physical perspectives linking property to organisational performance. Descriptive statistics are used to estimate the current state of the European campus.

Key publications:

Den Heijer, Alexandra and George Tzovlas (2014), The European campus – heritage and challenges, Information to support decision makers, Delft: Delft University of Technology, October 2014.

Den Heijer, Alexandra and George Tzovlas (2015), "The European campus of the future is the university city" in The Class of 2020 Annual Trend Report – Rolling out the Red Carpet, Amsterdam: November 2015, pp 22-23.

Den Heijer, Alexandra (2015), "Das europäische Modell eines City Campus ist smart, nachhaltig und inklusiv" in Below, Sally and Reiner Schmidt (2015), Auf dem Weg zur Stadt als Campus, Berlin: jovis Verlag, Januar 2015.

Den Heijer, A. (2011). Managing the university campus. Delft: Eburon Academic Publishers.

Key researchers:
Dr. Ir. Alexandra den Heijer
Ir. George Tzovlas

Research period:
March 2013 - Oct 2014

Campus NL

Key researchers:
Dr. Ir. Alexandra den Heijer
Ir. Monique Arkesteijn
Ing. Peter de Jong
Drs. Evi de Bruyne
Jeroen Meijler
Lotte Born

In collaboration with:
VSNU

Starting date:
Dec 2015 - Dec 2016

In the Netherlands fourteen publicly funded research universities accommodate more than 270.000 students and 53.000 staff members – together they manage about 4,4 million m2 Campus NL (gross floor area, data 2015/2016). This research project elaborates on past, present and future of Campus NL, based on literature, previous campus research – including Den Heijer's dissertation (2011) – analysis of recent (campus) strategy reports and interviews in 2016 with more than 35 campus directors, policy makers and board members of the fourteen Dutch universities.

This research project covers subjects like the changing academic place to learn and work, the total costs of (campus) ownership and sustainable campus ambitions. The paper will also discuss how applicable both the (DAS) research method and Campus NL results are to other universities and their campuses.

Research question:
What is the past, present and future of Campus NL?

Deliverables:
The results of this research are presented in four steps, aligning with the four tasks to design an accommodation strategy (DAS steps):

- (step 1) assessing the campus anno 2016, compared to 2006 and clarified with historical background,
- (step 2) exploring changing demand, based on developments in society and higher education,
- (step 3) generating future models, derived from ten campus trends and
- (step 4) defining strategic choices for Campus NL and their functional, financial and physical consequences for universities.

Methods:
The 'Campus NL' study is conducted by the Faculty of Architecture and the Built Environment TU Delft, commissioned by the Association of Universities in the Netherlands (VSNU). All fourteen Dutch universities took part. For this study, Alexandra den Heijer and her research team interviewed more than 35 accommodation officers at Dutch university campuses. They collected campus data, consulted the most recent university and campus strategies and held talks with financial directors, campus directors and executive boards. Den Heijer, the Campus Research Team's principal investigator, compared the conclusions with her thesis dating from 2011 and previous research, revealing trends in the use of space, quality, accommodation costs and the value added to the campus. The report, published in February 2017, is now on the desks of the Minister of Education and the House of Representatives.

Key publications:

Heijer, Alexandra den en Monique Arkesteijn, Peter de Jong (2017, forthcoming), "Campus NL – past, present and future of the Dutch campus" at European Real Estate Society (ERES), 24th annual conference in Delft, The Netherlands, June 28 – July 1, 2017 (conference website + ABSTRACT as submitted in January 2017).

TU Delft (2016), "Campus NL – Investeren in de toekomst" (boek/rapport in opdracht van VSNU en 14 universiteiten), Delft: TU Delft, Faculteit Bouwkunde, afdeling Management in the Built Environment (MBE), december 2016.

Smart Campus Tools

The 'Smart campus tools' research started because of a problem that is familiar to both users and campus managers alike: space that is reserved, but only partly in use. The hypothesis is that smart tools can help to solve this problem. A smart tool is a service or product which collects (real-time) information on space use to improve the space use on the current campus on the one hand, whilst supporting decision making on the future space use on the other hand. The subject matter is explored by conducting a literature search, by doing a survey of the practice at Dutch universities and by interviewing parties in other industries. 26 smart tools are found at Dutch universities, which are predominantly aimed at using the campus more effectively. In other industries smart tools are used that are comparable to those of universities, or which can be relevant to them. These smart tools are aimed more at improving the efficiency of space use, rather than the effectiveness. The tools at Dutch Universities of Applied Sciences can give direction for the next step in the development of smart tools at the universities. The tools at other parties can provide lessons for combining multiple data sources, although their implementability is limited.

Research question:
Which smart tools are in demand by the universities and which smart tools are available?

Deliverables:

- An overview of the smart tools found at the universities
- An overview of the smart tools found in other industry sectors
- A dashboard to be used to formulate an advice per university

Methods:
Literature search, survey (questionnaire & semi-structured interviews), semi-structured interviews

Key publications:

Christensen, K., Melfi, R., Nordman, B., Rosenblum, B., & Viera, R. (2014). Using existing network infrastructure to estimate building occupancy and control plugged-in devices in user workspaces. International Journal of Communication Networks and Distributed Systems, 12(1), 4-29. doi:10.1504/IJCNDS.2014.057985

Den Heijer, A. (2011). Managing the university campus. Delft: Eburon Academic Publishers.

Mautz, R. (2012). Indoor Positioning Technologies. (Habilitation Thesis), ETH Zürich, Zürich

Serraview. (2015). Managing Workplace Utilization. IoT & Other Technologies for Tracking Workplace Utilization. Retrieved from http://info.serraview.com/workplace-utilization-free-guide

Space Management Group. (2006). Space utilisation: practice, performance and guidelines.

Key researchers:
Ir. Bart Valks
Ir. Monique Arkesteijn MBA
Dr. Ir. Alexandra den Heijer
Ir. Arch. Herman Vande Putte

In collaboration with:
13 Dutch universities – all public universities with the exception of the Open University

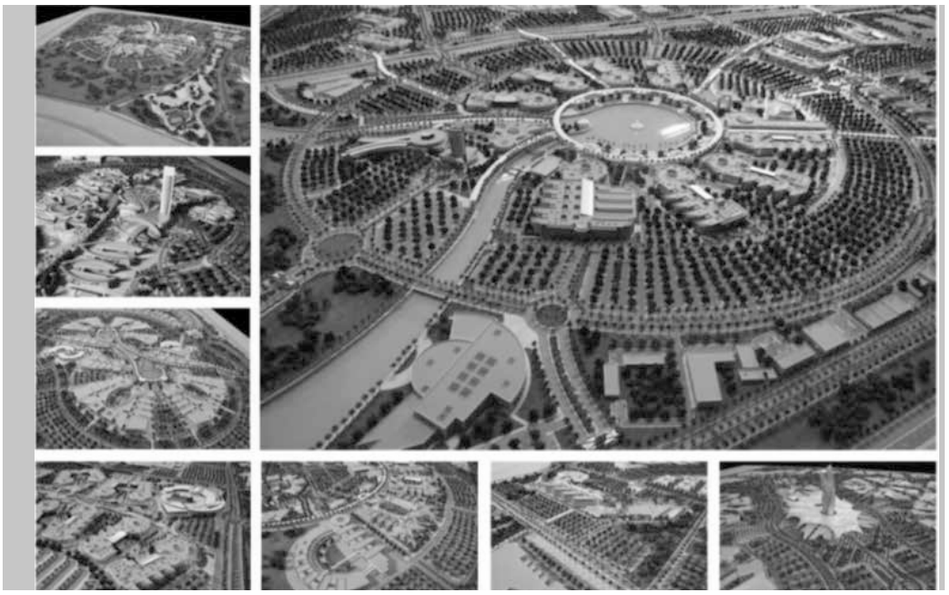
Research period:
Oct 2015 - Sept 2016

University Campuses in Saudi Arabia
Sustainability Challenges and Potential Solutions

Key researchers:
Naif Alghamdi, MSc

Supervision:
Prof. Ir. Hans de Jonge
Dr. Ir. Alexandra den Heijer

Research period:
2014 - present



Saudi Arabia has adopted a long-term vision for its education system with more focus on its higher education sector. It is investing heavily in higher education specially its physical facilities. The Kingdom is building over 20 new campuses for recently established universities. Major research problems in these new campuses are: location and accessibility; environmental considerations; standardisation (uniform design); and finally the demographic changes of the Saudi youth population. This research focuses on the environmental sustainability in campuses in Saudi Arabia. The objectives of the research are (1) to document the great developments in higher education infrastructure in the Kingdom, (2) to explore the environmental sustainability measurements in the-first-phase of college buildings and university campuses, and (3) to develop sustainable planning principles as 'guidelines' to aid improvement of higher education facilities, saving resources, and helping future generations to learn, study, and do research in a healthier, smarter, and greener environment.

Research question:
What information, tools, and approaches will allow existing and new college buildings and campuses in Saudi Arabia to become environmentally sustainable?

Deliverables:
A planning guidelines with a set of sustainable visions for the Ministry of Education and Public Universities, consisting of a set of recommendations as a detailed road map for improving the existing premises and preventing 'mistakes' from happening again in the future developments in university campuses in Saudi Arabia.

Methods:
First stage (Exploration): i) Identifying sources, ii) Defining sustainable campuses and analysing assessment tools and systems, and iii) Studying cases in Saudi Arabia through literature review, carrying out observations, distributing questionnaires, and doing some interviews with decision makers in nine cases. Second stage (Explanation): i) Redefining the research, ii) Selecting and studying cases from different parts of the world, and iii) Proposing the 'preliminary guidelines'. Third stage (Conclusion): i) Validating or testing the proposed guidance through interviewing Saudi and non-Saudi experts, and ii) Conclusion and recommendations.

Key publications:

Naif Alghamdi, (in press) "Assessing climate change and sustainability in public universities in Saudi Arabia", In 'Handbook of Climate Change Communication' edited by Walter Leal. New York, NY: Springer.

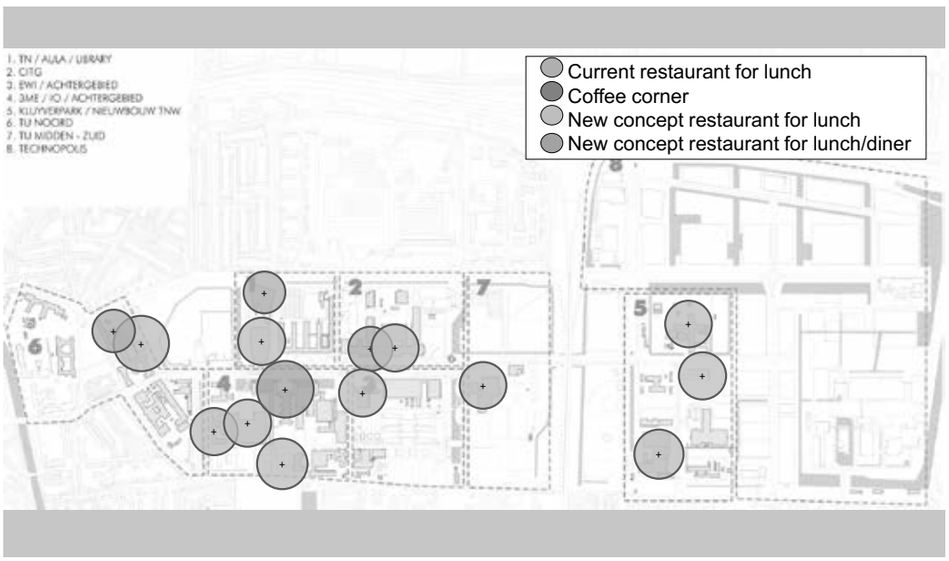
Naif Alghamdi, Alexandra den Heijer, Hans de Jonge, (2017) "Assessment tools' indicators for sustainability in universities: an analytical overview", International Journal of Sustainability in Higher Education, Vol. 18 Issue: 1, pp. 84-115, doi: 10.1108/IJSHE-04-2015-0071

Naif Alghamdi, (2014) "Higher education in Saudi Arabia: Achievements, challenges and opportunities" by Larry Smith and Abdulrahman Aboummoh (eds), Higher Education (International Journal of Higher Education Research), Vol. 69 Issue: 6, pp. 1019, doi: 1019. doi:10.1007/s10734-014-9798-x

Naif Alghamdi, (2014) "Managing the University Campus: Information to Support Real Estate Decisions" by Alexandra den Heijer, International Journal of Educational Management, Vol. 28 Issue: 5, pp. 610-612, doi: 10.1108/IJEM-02-2014-0013

Measuring added value in CRE alignment

Desiging and deciding real estate portfolios with preference-based accommodation strategy design procedure



One of the long-standing issues in the field of Corporate Real Estate Management (CREM) is the alignment of an organisation's real estate to its corporate strategy. CRE alignment is even defined by some as the raison d'etre of CREM, as the range of activities undertaken to attune corporate real estate optimally to corporate performance. Even though extensive research into existing CRE alignment models has provided us with valuable insights into the steps, components and variables that are needed in the alignment process, these models still fall short in a number of ways. To name but one, most models pay little to no attention to the design and selection of a new portfolio that adds the most value to the organisation.

The PAS design procedure is a decision support tool to remedy these shortcomings and thereby enhance CRE decision making. In the PAS procedure, decision makers define variables and iteratively test and adjust these variables by designing new alternative real estate portfolios. The PAS procedure ends when the alternative portfolio that adds most value to the organisation, i.e. has the highest overall preference score, is selected as the portfolio that optimally aligns real estate to corporate strategy.

Methods and deliverables:
To test in practice the procedure a mathematical model is made for two pilots studies at the Delft University of Technology. The pilot studies results reveal that, by completing the steps in the PAS procedure, the participants are able to express their preferences accordingly. They designed an alternative portfolio with more added value, i.e. a higher overall preference score, than their current real estate portfolio. In addition, they evaluated the design method positively. These positive results suggest that the PAS procedure is a suitable approach to CRE alignment. Moreover, the PAS design procedure is generic in nature and can be used for a wide range of real estate portfolios.

Key publications:

Arkesteijn, M. H., Valks, B., Binnekamp, R., Barendse, P. and De Jonge, H. (2015) 'Designing a preference-based accommodation strategy: A pilot study at Delft University of Technology', Journal of Corporate Real Estate, 17(2), 98-121. (outstanding JCRE paper of the year award in 2015)

Arkesteijn, M. H. and Binnekamp, R. (2013) 'Real estate portfolio decision making' in Gheorghe, A. V., Macera, M. and Katina, P. F., eds., Infranomics: sustainability, engineering design and governance, Dordrecht: Springer, 89-99.

Arkesteijn, M.H. & Volker, L (2012). The power of pluralism for urban strategies. Cities: the international journal of urban policy and planning, 31(April), 328-336. (TUD)

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Key researchers:
Ir. Monique Arkesteijn MBA

Supervision:
Prof. Ir. Hans de Jonge
Prof. Jonathan Barzilai

Research period:
2011 - present

University as a Place To Be
Creating a sense of belonging on campus

Key researcher:
Salomé A. Bentinck MSc

In collaboration with:
University of Amsterdam

Research period:
2012 - present

The purpose of the research 'University as a place to be' is to identify the building-related conditions of face-to-face communication in Higher Education. The focus is on unplanned face-to-face communication as part of social interaction, so called chance encounters. The research will be executed by analysing the perception of users (staff and students) and by identifying satisfiers and dissatisfiers concerning the built environment. In particular the role of physical characteristics of buildings and their immediate surroundings in the contribution to social interaction will be examined. Physical characteristics include the design, the programming of functions as well as aspects of facility management.

The data are collected through surveys and interviews in departments of Higher Education Institutions in Amsterdam with relocations plans, which therefore provided an opportunity to carry out a baseline survey in the 'old' building and a second measurement in the 'new' building.
The importance of face-to-face communication in education and research is clarified by a literature study on knowledge creation. The required presence on campus, necessary for face-to-face communication can possibly be eased by the social and physical attraction to the place. This proposition on the importance of the sense of belonging is explained by a literature review on the concept of place attachment. Knowledge creation, place attachment, and face-to-face communication are related in the conceived conceptual model.

The case studies executed before and after the relocation of the involved Higher Education Institutes give the possibility to evaluate and to assess what physical characteristics contribute to chance encounters and the development of place attachment in a university building

Research question:
What physical characteristics of campus and buildings support face-to-face communication and place attachment?
How do the different group of users of university buildings perceive their building in respect to aspects that support face-to-face communication, chance encounters, and attachment?

Methods:
The study is designed as a mixed method study in which both qualitative methods (interviews, photo report, observations, and document analyses) and a survey were conducted before and after relocation of a number of departments of an Amsterdam Higher Education Institution. In addition, a photo report of chance encounters was made at the TU Delft and the University of Amsterdam.

Key publications:

Bentinck, S. A. (2016). From bricks to breeding ground - University real estate in the digital society presented at the EUROPEAN REAL ESTATE SOCIETY, 23rd Annual Conference June 8-11, 2016, Regensburg, Bavaria/ Germany.

Bentinck, S. A. (2015). Pleidooi voor de academische plek Houd rekening met hoe mensen zijn. TH&MA : tijdschrift voor hoger onderwijs & management, 22(5), 6-9.

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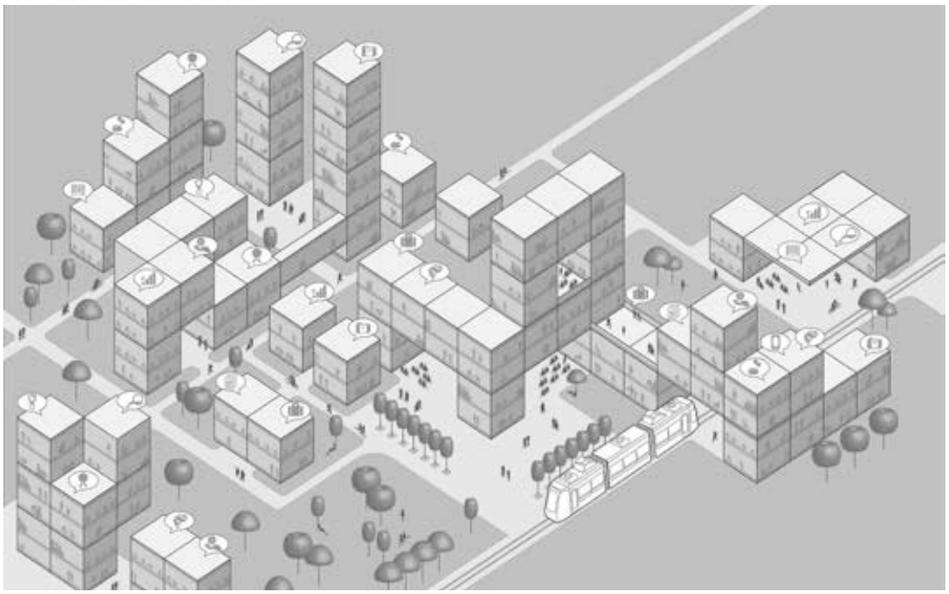
Technology Campuses in Cities.

A study on the relation between innovation and the built environment at the urban area level.



This thesis examines the development of technology campuses as built environments and their role in stimulating innovation. Technology campuses entail a variety of built environments developed to accommodate technology-driven research activities of multiple organisations. The science park is the most common type of technology campus. Other types include the campuses of universities of technology and corporate R&D parks.

Throughout two core studies, this study developed a model for understanding and managing the relationship between the built environment and innovation at the area level. The first study is an exploratory research that uncovers and positions the link between innovation and the built environment using inputs from theory and empirical evidence from 39 technology campuses worldwide. The second study is an explanatory research that clarifies the relationship between innovation and the built environment based on empirical evidence in the practice of campus development based on two cases (The Massachusetts Institute of Technology Campus in Cambridge, the United States and the High Tech Campus Eindhoven in Brainport Eindhoven Region, the Netherlands).

Research question:
'How does the built environment stimulate innovation in technology campuses?'

Deliverables:

A model positioning the built environment as a catalyst for innovation in technology campuses demonstrated by location decisions and interventions facilitating five interdependent conditions required for innovation in particular contexts.
The empirical evidence supporting the model is structured and converted into information available to decision makers involved in the development of technology campuses. The so-called 'campus decision maker Toolbox' provides instruments that guide planners, designers and managers of campuses and cities during different stages of campus development.

Methods:
Literature review, survey of 39 technology campuses, theory building from case studies (open and semi-structured interviews, mapping, document analysis)

Key publications:

Curvelo Magdaniel (2016) Technology campuses and cities, a study on the relation between innovation and the built environment at the urban area level. PhD Thesis TU Delft.

Den Heijer, A. C., & Curvelo Magdaniel, F. T. J. (2012). The university campus as a knowledge city: exploring models and strategic choices. International Journal of Knowledge-Based Development, 3(3), 21.

Curvelo Magdaniel, F. T. J., De Jonge, H. & Den Heijer, A. C., (2017-forthcoming). Campus development as catalyst for innovation. Journal of Corporate Real Estate.

Curvelo Magdaniel, F. T. J., Den Heijer, A. C., & De Jonge, H. (2017-forthcoming). The locations of innovation described through thirty-nine tech-campuses. Competitiveness Review.

Key researchers:
Dr. Ir. Flavia Curvelo Magdaniel

Supervision:
Prof. Ir. Hans de Jonge
Dr. Ir. Alexandra den Heijer

Research period:
June 2011 - September 2016

About the author and editors

Dr. Ir. Flavia Curvelo Magdaniel is a post-doctoral researcher of Real Estate Management at the Department of Management in the Built Environment, Faculty of Architecture, Delft University of Technology. She was educated and worked as an architect in Bogotá, Colombia. In 2008, she moved to the Netherlands to pursue a masters education in Real Estate & Housing. In 2010, she obtained the degree of MSc at TU Delft and soon after her graduation she joined the department of MBE as a PhD candidate. Her dissertation focused on the development of technology campuses combining insights from Corporate Real Estate Management and Urban Development Management. Before and while working in her PhD research Flavia performed graphic design works for the department of MBE, including the design of the dissertation 'Managing the university campus', research reports and marketing brochures for education and research. Besides her appointment at TU Delft, Flavia works as an independent graphic designer. Nowadays, TU Delft features one of her original designs in the coffee cups and vending machines of the campus.

Dr. Ir. Alexandra den Heijer is associate professor of Real Estate Management at the Department of Management in the Built Environment, Faculty of Architecture, Delft University of Technology. She has a background in Architecture (BSc) and Management (MSc). Her specialisation is planning, design and management of university campuses and buildings. She is the leading researcher of TU Delft's Campus Research Team. All Dutch universities have supported her research for the past fifteen years. Apart from the Dutch situation she has explored international references and has written many reports, articles and papers on the university and campus of the future, trends and changing concepts and campus strategies. Next to her academic position she has (had) positions as consultant, (supervisory) board member and jury chair in the housing, real estate and construction sector. Alexandra operates in an extensive network of national and international campus management experts – both in academia and in practice. She gives lectures for campus decision makers around the world.

Ir. Monique Arkesteijn is assistant professor of Real Estate Management (REM) at the Department of Management in the Built Environment, Faculty of Architecture, Delft University of Technology. She was one of the first MBE graduates in 1993. She had various positions as project manager and consultant at Starke Diekstra and as partner at Diephuis Stevens. She re-joined the REM section of Hans de Jonge in 2003 after finishing a MBA. Since 2013 she is the team leader of the REM section and as such a member of the daily board. Her research topics include CRE strategies, CRE alignment and measuring added value for corporate, public and semi-public organisations. Monique is in the last phase of her PhD study on preference-based accommodation strategy design. Currently she is board member of CoreNet Global, the world's leading association for corporate real. Monique is the (co-)author of Designing an Accommodation Strategy (2009), The power of pluralism for urban strategies (2012) and the award winning paper in the Journal of Corporate Real Estate on Designing a preference-based accommodation strategy (2015).

Prof. Ir. Hans de Jonge is emeritus professor Real Estate Management (REM) at the Department of Management in the Built Environment, Faculty of Architecture, Delft University of Technology. He is one of the founders of the (MBE) department in 1991, was department chair for ten years (1996-2006) and initiated the campus research team in the mid nineties. He has always combined his academic position with leadership positions in practice. In the past twenty years he has been chairman of the board of the Brink Groep, a group of businesses in the field of management, consultancy and automation for the building, housing and real estate sector. He is furthermore closely involved with the Master City Developer (MCD) post-doctoral course, a joint initiative of TU Delft, Erasmus University Rotterdam and the Ontwikkelingsbedrijf Rotterdam (Rotterdam local authority development company). For his contribution to the field he received in 2005 the prestigious Leermeesterprijs of the TU Delft University Fund. In the past 25 years of his professorship he has guided numerous MSc and PhD students and research projects and initiated various knowledge centres and valorisation networks.

TU Delft Delft University of Technology